

POSTER SESSION

1024 Strain and Strain Rate Imaging

Sunday, March 06, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 9:00 a.m.-10:00 a.m.

1024-63 A New Phase Analysis Method for Evaluating Abnormal Wall Motion From Myocardial Ischemia and Desynchronization Generated by Pacing

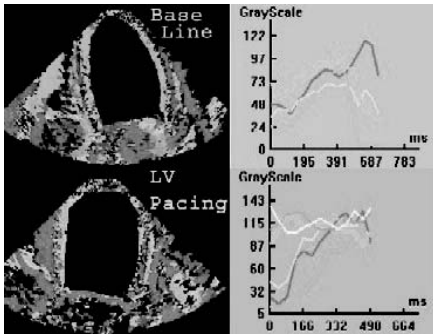
Xiaokui Li, Lei Sui, Helene Houle, James Pemberton, Jian-Feng Chen, Patrick von Behren, Robert I. Lowe, Timothy Thigpen, Michael Jerosch-Herold, David J. Sahn, Oregon Health & Science University, Portland, OR, Siemens Ultrasound, Mountain View, CA

**Background:** We tested a simple rapid wall motion phase analysis software program running on 2D DICOM echo images to evaluate myocardial wall motion and ventricular synchronization.

**Methods:** 4 pigs were underwent an open chest procedure for multiple site pacing [left circumflex (LCX), LV Septum (S), LV posterior wall (LV P) and right ventricle (RV)] to create desynchronize rhythm and occlusion (proximal, middle or lower LAD and LCX) to create ischemia simultaneously. An ACUSON Sequoia™ echocardiography system (5MHz) (SIEMENS Ultrasound) was used for scanning at each state analyzed for systolic phase delay (SPD) relative to the R-wave. SPD = [(initial time ÷ R-R duration) x 360°] and the standard deviation (SD) on peak contraction as an indicator of synchrony.

**Results:** For all base line states: SPD < 180°, mean = 119.76 ± 38.85. During pacing (LCX, LVP, LVS, RV and RVP) without ischemia, SPD was still < 180° but averaged mean and SD was raised to 152.43 ± 53.05. All occluded (OCC) segments' SPD > 180° averaged mean and SD = 219.2 ± 91.6 for OCC with pacing and 216.71 ± 72.92.64 for OCC with no pacing and 215.83 ± 54.70 for released OCC. Color codes Parametric color maps of phase showed the delay allowed rapid, efficient, visualization of abnormal phase delay.

**Conclusions:** This new method is feasible and fast for future detection of abnormal heart motion and cardiac desynchronization.



1024-64 Two-Dimensional Strain Imaging Echocardiography for the Evaluation of Global Left Ventricular Function: Early Validation Studies

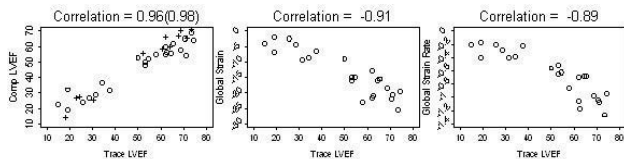
Christian S. Lopez, Rush University Medical Center, Chicago, IL

**Background:** Novel computer software (General Electric Ultrasound, Milwaukee, WI) is capable of automatic frame-by-frame tracking of natural acoustic markers during the heart cycle, yielding objective measures of contractility.

**Methods:** Computer generated left ventricular ejection fraction (LVEF), global longitudinal strain (GLS), and GLS rate (GLSR) were calculated from 20 normal and 23 abnormal apical 2, 3, and 4-chamber loops and compared to manual endocardial tracing LVEF.

**Results:** Mean ± 1SD and significance of difference between normal and abnormal loops:

Loops	n	Tracing LVEF (%)	Computer LVEF (%)	GLS (%)	GLSR (%/second)
All	43	50.7±20.3	46.9±16.6	-13.7±7.4	-0.66±0.36
Normal	20	67.8± 5.7	60.1± 6.5	-20.2±3.0	-0.98±0.19
Abnormal	23	35.9±16.3	35.5±13.9	- 8.1±5.1	-0.37±0.19
t-statistic		6.4&	5.3&	7.0&	7.1&



Opticon® (+ in the left figure) n=12, r=0.98.

**Conclusion:** early validation studies suggest excellent correlation between computer-generated global systolic parameters and traditionally traced LVEF.

1024-65 Altered Diastolic Function in Asymptomatic Patients Who Were Newly Diagnosed With Hereditary Hemochromatosis: Utilization of Strain Rate Imaging

Yukitaka Shizukuda, Charles D. Bolan, Dorothy J. Tripodi, Vandana Sachdev, Tammy Nguyen, Ernst Inez, Yu Ying Yau, Susan F. Leitman, Douglas R. Rosing, NHLBI/NH, Bethesda, MD

**Background:** Abnormal diastolic function has been reported in patients with hereditary hemochromatosis (HH), particularly advanced stage patients; however, little is known when the abnormalities begin. We hypothesized that diastolic functional alteration develops at the early stages of iron overload.

**Methods:** Through an NHLBI-sponsored "Heart study of hemochromatosis" protocol, we recruited 11 consecutive newly diagnosed HH patients (ND, aged 49±11, 2 female, mean±SD) and 9 normal controls without any known mutations of HH (aged 45±6, 4 female). All HH patients had confirmed C282Y homozygosity and documented iron overload. All subjects were NYHA Functional Class I. Left ventricular (LV) diastolic function was comprehensively assessed by echocardiography using conventional Doppler measurements (CD), pulsed wave tissue Doppler (PW), and strain rate imaging by the Vivid 7 system (SRI) in the apical views prior to the third phlebotomy therapy.

**Results:** The serum ferritin (1348±1008 vs 51±39 µg/L, P=0.0016) and transferrin saturation (72±20 vs 22±8%, P<0.0001) were significantly higher in ND compared to controls. Echocardiographically measured LV mass (136±38 vs 118±30g, P=NS) and systolic function by strain imaging were comparable between the two groups. No subjects had more than mild mitral regurgitation. CD detected altered diastolic LV filling demonstrated by significantly lower mitral inflow propagation slope (54±17 vs 75±13 cm/sec², P=0.005), increased pulmonary vein systolic and diastolic peak velocity ratio (1.2±0.2 vs 1.0±0.1, P<0.05), and increased differences in duration of pulmonary vein atrial (A) filling to mitral inflow A filling (-38±39 vs -7±15 msec, P<0.05) in ND. SRI demonstrated increased peak diastolic A strain rate in both the basal septum (1.9±0.6 vs 1.2±0.4 sec⁻¹, P<0.01) and lateral wall (1.3±0.5 vs 0.8±0.3 sec⁻¹, P<0.05) without showing significant differences in early filling strain rate. PW failed to detect any changes of diastolic function in ND.

**Conclusions:** Our results suggest that altered LV diastolic filling including changes in active atrial filling mechanics is present in newly diagnosed HH patients.

1024-66 Longitudinal and Radial Regional Strain Obtained From Gray-Scale Conventional Echocardiography

María Jesus Ledesma-Carbayo, Andres Santos, Patricia Mahía, Miguel Angel Garcia Fernández, Jan Kybic, Norberto Malpica, Esther Pérez David, Manuel Desco, Hospital General Universitario Gregorio Marañón, Madrid, Spain

**Background:** Strain measurements using echocardiography are obtained as the spatial gradient of Doppler velocities, inheriting its limitations due to the angular dependency. Our work presents a preliminary validation of a new method to compute the longitudinal (Sl) and axial (Sr) strain components from conventional gray scale echocardiographic images using non-rigid spatio-temporal registration based on semilocal parametric models of the deformation.

**Methods:** A total number of 46 echocardiographic basal and mid segments from the septum and inferior wall were analysed. These segments were qualitatively classified into three different contractility patterns. Cardiac motion field was obtained for each pixel in the regions of interest extracting Sr and Sl. Results were assessed by means of a one-way analysis of variance (ANOVA) with Sheffé post-hoc correction for multiple comparisons.

**Results:** Strain components Slong and Sax showed significant differences (p<0.05) between segments with normal contractility and hypokinetic and akinetic ones. Slong showed also significant differences between akinetic and hypokinetic segments.

**Conclusion:** Obtaining Sr and Sl from echocardiographic conventional imaging using spatio-temporal non-rigid registration techniques allows to quantify regional systolic function , overcoming the limitations of the Doppler based techniques.

m±SD	Normal (n=24)	Hypokinetic (n=9)	Akinetic (n=13)
Sr	55.8 ±21.8 %	20.8±8.7 %	13.9±10.7 %
Sl	-15.2±6.0 %	-8.5±6.8%	-0.5±7.6%

POSTER SESSION

1025 Tissue Velocity and Strain in Ischemic Disease

Sunday, March 06, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 9:00 a.m.-10:00 a.m.

1025-87 Detection of Significant Stenotic Lesion in the Left Anterior Descending Coronary Artery using Adenosine Triphosphate Stress Strain Imaging: Comparison with Coronary Flow Velocity Reserve Measurement using Transthoracic Doppler Echocardiography

Tsutomu Takagi, Junichi Yoshikawa, Takagi Cardiology Clinic, Kyoto, Japan, Osaka City University, Osaka, Japan

**Background** Usefulness of adenosine triphosphate (ATP) stress strain imaging in diagnosis of coronary artery disease remains unclear.

**Methods** To evaluate the usefulness of ATP stress strain imaging in diagnosis of coronary artery disease, 25 patients were studied; 8 patients had significant stenotic

lesion in the left anterior descending coronary artery (LAD), and 17 patients did not have significant LAD lesion. All patients underwent ATP stress strain imaging and coronary flow velocity reserve (CFVR) measurement using transthoracic Doppler echocardiography simultaneously. Peak strain and time to peak strain (TPS) in the mid-apical septal segment were measured at baseline and during intravenous ATP infusion (0.14mg/kg/min). TPS ratio was calculated as the ratio between TPS during ATP and TPS at baseline. Coronary flow velocities of the distal LAD were measured at baseline and during ATP infusion. CFVR was calculated as the ratio between mean diastolic flow velocity during ATP infusion and mean diastolic flow velocity at baseline.

**Results** CFVR in patients with the LAD lesion was significantly smaller than that in patients without LAD lesion (1.7 +/- 0.2 vs 2.3 +/- 0.6, respectively,  $p = 0.007$ ). There were no significant difference between two groups in peak strain at baseline (-22.7 +/- 5.8% vs -19.8 +/- 7.7%, respectively,  $p = 0.356$ ), peak strain during ATP (-22.2 +/- 5.0% vs -22.3 +/- 6.5%, respectively,  $p = 0.961$ ), or TPS at baseline (439 +/- 70ms vs 451 +/- 49ms, respectively,  $p = 0.638$ ). However, TPS during ATP in patients with the LAD lesion was significantly greater than that in patients without LAD lesion (552 +/- 45ms vs 404 +/- 67ms, respectively,  $p < 0.001$ ). As well as, TPS ratio in patients with LAD lesion was significantly greater than that in patients without LAD lesion (1.3 +/- 0.2 vs 0.9 +/- 0.1, respectively,  $p < 0.001$ ). A cut-off value  $< 2.0$  of CFVR had a sensitivity of 100%, a specificity of 82%, diagnostic accuracy of 88% for the presence of significant LAD lesions. A cut-off value  $\geq 1.1$  of TPS ratio had a sensitivity of 88%, a specificity of 88%, diagnostic accuracy of 88% for the presence of significant LAD lesions.

**Conclusions** ATP stress strain imaging is useful in diagnosis of significant LAD lesions.

1025-88

#### Systolic Pulsed Tissue Doppler Parameters are Highly Predictive of TIMI-III flow in the Infarct Related Artery Following Primary Percutaneous Intervention in Acute Anterior Myocardial Infarction. Correlation with Myocardial Blush Grade, ST-Segment Resolution, and Myocardial Salvage Index

Amal E. Ayoub, Ghada S. Al-Shahed, Waleed A. AL-Hammadi, Mohamed S. Abdel-Wahab, Hany M. Awadalla, Ain Shams University, Cairo, Egypt

**Background and Aim:** Despite an apparently normal flow in the epicardial infarct-related artery (IRA), even patients with TIMI-3 flow in the IRA may not achieve adequate myocardial reperfusion at the tissue level. The aim of this study is to evaluate the clinical applicability of pulsed wave tissue Doppler parameters in patients with acute ST segment elevation myocardial infarction (MI) undergoing primary percutaneous coronary intervention (PCI) as an indicator of successful myocardial reperfusion at the tissue level.

**Methods:** 100 patients with acute anterior (MI) within 6 hours were enrolled. All patients underwent PCI, after loading with Clopidogrel. All 100 patients underwent pulsed wave tissue Doppler (PTD) examination within 2 days of the acute myocardial infarction, and 2 weeks later. The machine mode was switched to tissue velocity imaging (TVI) mode to encode myocardial velocities. PTD samples were recorded from six different locations at the level of the mitral annulus (anterior, inferior, lateral, posterior, anterior septum, posterior septum), using the apical two- and four-chamber and long-axis views. At each point of examination, peak systolic wave (S) was determined. The peak value of the S-wave was taken as a determinant of systolic function.

**Results:** Systolic PTD measurements at the mitral annular level in patients with anterior MI and Myocardial Blush Grade (MBG) 0-1 significantly deteriorated between 2<sup>nd</sup> day and 2<sup>nd</sup> week (6.5 m/second and 5.3 m/second, respectively;  $p=0.01$ ). Systolic PTD parameters at 48 hours and 2 weeks improved significantly in patients with anterior MI and MBG 2-3 (5.4 m/second and 7.1 m/second, respectively;  $p=0.005$ ). There was a significant direct correlation between TIMI-3 flow in the infarct related artery (IRA) and improvement of Systolic PTD measurements at two weeks ( $p=0.03$ ). A significant direct correlation between ST-segment resolution, Myocardial Salvage Index (MSI), and improvement of the Systolic PTD parameters at two weeks was also seen ( $P=0.01$ , and  $0.03$ ; respectively).

**Conclusion:** Systolic pulsed tissue doppler parameters directly correlate with TIMI-III flow in the IRA, MBG, and ST-Resolution following primary PCI in AMI.

1025-89

#### Transmural Myocardial Postsystolic Thickening and Dyssynchrony in Myocardial Infarction Assessed by Strain M-Mode Imaging.

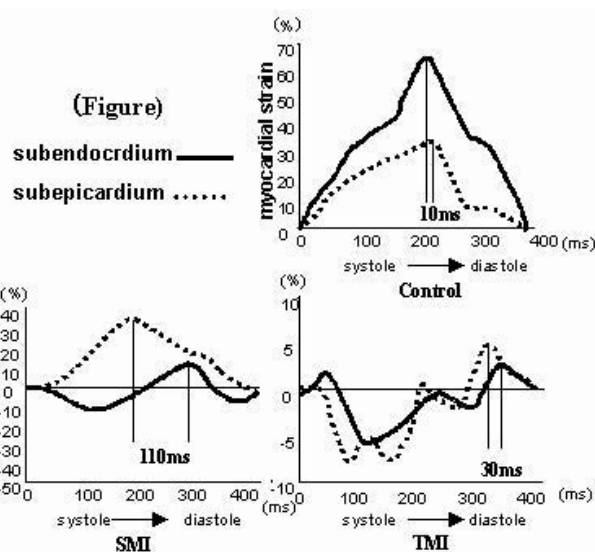
Takeshi Maruo, Satoshi Nakatani, Yin-Tie Jin, Kazunori Uemura, Masaru Sugimachi, National Cardiovascular Center, Osaka, Japan, National Cardiovascular Center Research Institute, Osaka, Japan

**Background:** By using a newly developed strain M-mode imaging system, we can assess spatio-temporal distribution of myocardial strain on the myocardial wall. Ischemic myocardium exhibits postsystolic thickening (PST). We investigated if there was PST in the subendocardium and subepicardium.

**Methods:** We created subendocardial infarction (SMI) by 90-min left circumflex coronary occlusion and subsequently, transmural infarction (TMI) by intracoronary microbeads injection in 11 open-chest dogs. Spatio-temporal strain distribution was analyzed at the basal and mid posterior walls obtained from tissue strain left ventricular short-axis image. We measured the time from Q-wave to the timing of peak subendocardial strain (Endo-T) and that of peak subepicardial strain (Epi-T).

**Results:** Endo-T in SMI (340±42ms,  $p=0.017$ ) and TMI (320±49ms,  $p=0.004$ ) were longer than that in the control (264±44ms). Epi-T in TMI (304±69ms) was longer than that in the control (261±45ms,  $p=0.044$ ) and SMI (214±67ms,  $p=0.004$ ). Accordingly, the difference between Endo-T and Epi-T in SMI (127±51ms) was longer than that in the control (3±10ms,  $p<0.001$ ) and TMI (16±41ms,  $p<0.001$ ), suggesting significant transmural dyssynchrony in SMI.

**Conclusions:** The subendocardium in SMI showed PST, while the subepicardium did not. Strain M-mode imaging was useful to estimate the transmural dyssynchrony in myocardial infarction.



1025-90

#### Can Assessments of Subepicardial Function with Myocardial Strain Rate Imaging and Integrated Backscatter Distinguish Transmural Extent of Infarction?

Jonathan Chan, Rodol Leano, Thomas H. Marwick, University of Queensland, Brisbane, Australia

**Background:** Transmural extent of infarction (TME) may be an important determinant of functional recovery and remodeling. Recent animal data suggest that strain rate imaging (SRI) may be able to identify subendocardial ischemia. We compared SRI and cyclic variation of integrated backscatter (CVIB) for predicting TME and in the quantitative assessment of regional subepicardial function.

**Methods:** 49 post myocardial infarct (MI) patients (61±10 y.o, EF 41±10%) underwent tissue Doppler echocardiography (TDE) and contrast enhanced magnetic resonance imaging (CMR). A 15mm x 2mm sampling volume (tracked to wall motion) was placed over the long axis subepicardial region of each segment during TDE offline analysis to measure peak longitudinal systolic strain rate, peak longitudinal systolic strain, and CVIB. Findings were compared with TME classified into 2 categories of scar thickness by CMR: Non-transmural (TME<50%), and transmural (TME≥50%).

**Results** Of 213 segments identified with resting wall motion abnormalities, 145 segments showed delayed hyperenhancement on CMR. Peak strain, strain rate and CVIB were similar with no significant differences between transmural and non-transmural infarcts regardless of the echo modality.

CMR Scar Thickness	Peak Strain	Strain Rate	CVIB
Non-transmural Scars (n=73)	-13.3 ± 5.3	-0.8 ± 0.5	5.1 ± 2.9
Transmural Scars (n=72)	-12.5 ± 6.2	-0.8 ± 0.4	4.6 ± 3.3
P value	NS	NS	NS

**Conclusions:** In contrast to previous findings in animal models, neither SRI nor CVIB can differentiate TME in humans. These results suggest that subendocardial dysfunction results in early loss of long axis function despite tissue integrity in the subepicardium.

1025-91

#### Diastolic Strain Rate Patterns Allow Ischemia Detection at Rest

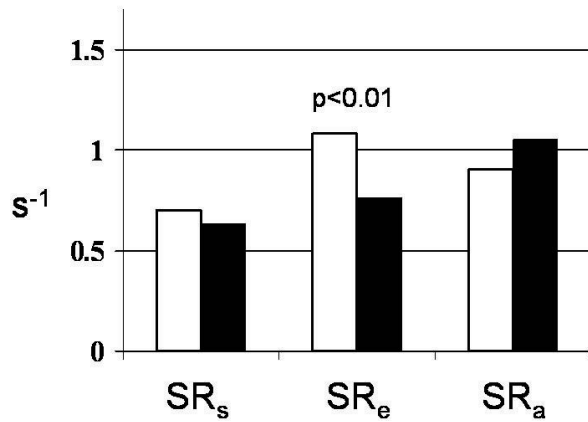
Hsin-Yueh Liang, Sanderson Cauduro, Stig Urheim, Chiranjit Rihal, Marek Belohlavek, Bijoy Khandheria, Fletcher Miller, Patricia Pellikka, Theodore P. Abraham, Mayo Clinic, Rochester, MN

**Background:** Energy dependent early diastolic relaxation is thought to be affected earlier in ischemia than systole. We used strain echocardiography (SE) to evaluate whether regional diastolic strain rates can detect segments subtended by stenosed coronary arteries at rest.

**Methods:** We prospectively imaged 54 consecutive patients during coronary angiography. Longitudinal systolic (SRs), early (SRE) and late (SRA) diastolic strain rates were measured in the 3 major vascular territories. Regions subtended by ≥70% coronary stenosis were labeled ischemic and compared to the same region in patients with non-significant coronary stenosis.

**Results:** Of 54 patients (34 males), 40 had >70% coronary stenosis (1 vessel in 9, 2 vessel in 18, 3 vessel in 13) and 14 had normal coronaries. There were no significant differences between the normal and ischemic group with regards to age (64±10 vs. 62±11,  $p=NS$ ), clinical variables (hypertension, diabetes, dyslipidemia), systolic or diastolic blood pressure (137±28 vs. 130±25 and 70±11 vs. 68±12, both  $p=NS$ , respectively) and ejection fraction (57±12 vs. 55±12,  $p=NS$ ). Peak SRE was significantly reduced in ischemic compared to normal regions in all 3 vascular territories. Peak SRs and SRA were similar in both regions (Figure).

**Conclusions:** Abnormal early diastolic mechanics in regions subtended by significantly stenosed coronary arteries are recognizable by a reduced SRE at rest despite similar SRs. SE may provide a novel, quantitative means of detecting ischemia at rest.



**1025-92 Novel Myocardial Viability Index Assessed by Strain Rate Imaging Correlates With Left Ventricular Diastolic Function in the Early Phase After Acute Coronary Syndrome**

Wook-Jin Chung, Eun Ok Shim, Kyung Leem Choi, Woong Chol Kang, Seung Hwan Han, Kwang Kon Koh, Tae Hoon Ahn, In Suck Choi, Eak Kyun Shin, Gil Heart Center, Gachon Medical School, Incheon, South Korea

**Background:** Experimental studies showed myocardial viability may influence on the diastolic function of left ventricle (LV) in the early phase after acute coronary syndrome (ACS). But there were few reports about this relationship in human.

**Methods:** 93 consecutive patients with ACS and akinetic wall motion in at least two segments underwent low dose dobutamine stress echocardiography (upto 10 mcg/kg/min) to assess myocardial viability on 7±2 days after the event. Myocardial viability was quantitatively evaluated by a strain rate imaging parameter, the percent change of time to the onset of regional relaxation (T<sub>r</sub>) as well as wall motion score index. At the same time, various echocardiographic diastolic parameters were measured. Within 6 hours after the study, left and right heart catheterizations for recording of pressures were performed. Myocardial viability index (MVI) was newly devised as a multiplication of numbers of akinetic segment and binary viability determinant by the percent change of T<sub>r</sub>.

**Results:** Patients (68.8% men, mean age 59.9±1.3 years, 59.2% anterior wall, 48.9% ST-segment elevation) were tolerated low dose dobutamine stress echocardiography without significant complications. MVI showed significant linear correlations with left atrial volume index, duration of pulmonary venous atrial flow reversal, deceleration time of transmitral E wave, systolic fraction of pulmonary venous flow and transmitral peak E' (mitral annular peak E' velocity ratio (r=0.44, p=0.00 and r=0.31, p=0.00 and r=-0.29, p=0.01 and r=-0.25, p=0.02 and r=0.22, p=0.04, respectively). Also, interestingly, MVI showed significant linear correlation with invasive pulmonary capillary wedge pressure (r=0.72, p=0.00). But changes of wall motion score index didn't showed any significances in correlation with diastolic functional parameters.

**Conclusions:** Novel MVI correlates with LV diastolic functional parameters reflecting chamber remodeling after ACS. So, MVI acquired by strain rate imaging on low dose dobutamine stress echocardiography may provide a useful prognostic information for LV remodelling in the early phase of ACS.

**1025-93 In Vivo Evaluation of X-ray Diffraction from the Left Ventricular Wall of Mouse Hearts**

Ryuji Toh, Naoto Yagi, Seinosuke Kawashima, Tomoya Yamashita, Masakazu Shinohara, Tomofumi Takaya, Shigeru Masuda, Mitsuhiro Yokoyama, Kobe University Graduate School of Medicine, Kobe, Japan, Spring-8/JASRI, Sayo, Hyogo, Japan

**Background:** Equatorial x-ray diffraction patterns have been studied in isolated heart muscles. It is confirmed that the relative intensity of the two main equatorial reflections, (1,0) and (1,1), depends on both the sarcomere length and the state of the muscle. Here we show x-ray diffraction from the left ventricular wall of a murine beating heart without thoracotomy, which is the first occasion to study them in this way.

**Methods and Results:** The experiments were made in the third generation synchrotron radiation facility, SPring-8. Briefly, The beam was set at the free wall of the left ventricle via the 3rd intercostal space from the anterior chest vertically. To fix the position of the heart in the thorax during irradiation, animals were kept apnea for a while after mechanical hyperventilation. With the beam at the epicardium surface of the left ventricle, well-oriented strong equatorial reflections were observed. The reflections became vertically split arcs when the beam passed through myocardium deeper in the wall, and rings were observed when the beam passed in the inner myocardium of the wall. To evaluate the global changes of whole heart structure in pathological condition using this technique, we used the doxorubicin (DOX)-induced cardiomyopathic mouse model. Male C57 BL/6 mice were randomly assigned to DOX-treated group (n=7) or control group (n=10). Animals were treated with 5 mg/kg of DOX or the same volume of saline intraperitoneally every 3 days over a week, resulting in a total cumulative dose of 15 mg/kg, and subsequently left for a week to leave only a damaged heart. The (1,0) lattice spacing, which is equal to  $\sqrt{3}/2$  of the distance between centers of nearest thick filaments, was obtained from the peak position of the (1,0) reflection. The (1,0) lattice spacing in diastole was significantly larger in DOX group than that in control (41.8±0.2 vs. 40.4±0.2 nm, p<0.001). We speculate that this was due to the increase in swelling of myocardium resulting from the administration of DOX.

**Conclusion:** X-ray diffraction study on hearts in living subjects could be a novel and useful tool to explore the molecular basis of cardiac disease.

**1025-94 Identifying Ventricular Dyssynchrony: Comparison of Pulsed Doppler Tissue Imaging to Other Echocardiographic Techniques**

Shrikanth P. Upadya, Craig McPherson, Sheikh Mahfuzul Hoq, Jeffrey Banker, Na Chu, Gilead Lancaster, Stuart Zarich, Yale University School of Medicine (Bridgeport), Bridgeport, CT

**Background:** Emerging echocardiographic technologies, including pulsed Doppler tissue imaging (PDTI), are being increasingly used to identify ventricular dyssynchrony and select patients (pts) for cardiac resynchronization therapy. While technically simpler methods involving M-mode or differences in the time between aortic and pulmonary ejection have been used in some studies, they have not been compared directly with more complex PDTI techniques.

**Methods:** Indices of PDTI included: 1) Intraventricular delay (LVD) = differences in electro-mechanical systolic delay in the lateral, septal, anterior inferior and posterior LV walls (abnormal: > 40 ms); 2) Interventricular delay (RLVD) = difference between the RV free wall and the most delayed left ventricular free wall (abnormal: > 40 ms); 3) Sum dyssynchrony (Sum D) = LVD + RLVD (abnormal: > 100 ms); and 4) Septal to lateral delay (SLD) = difference in electro-mechanical systolic delay between the septal and lateral walls by color M-mode DTI (abnormal: > 60 ms). Other methods measured were 1) Septal to posterior wall delay (SPWMD) = difference in systolic delay between the septal and posterior walls by M-mode (abnormal: > 130 ms); 2) Pulmonary-Aortic Delay (Q<sub>PW/Q<sub>A</sub></sub>) = difference in electro-mechanical delay, using flow Doppler, from pulmonary ejection to aortic ejection (abnormal: > 40 ms).

**Results:** Twenty pts (15 men, mean age = 70 years, 17 with ischemic cardiomyopathy) were evaluated. Dyssynchrony, defined as abnormal LVD by PDTI, was noted in 12 pts. When compared to LVD, the Pearson correlation coefficient (r) for other indices of ventricular dyssynchrony were as follows: Sum D = 0.98; RLVD = 0.899; SLD = 0.972; Q<sub>PW/Q<sub>A</sub></sub> = -0.237; and SPWMD = 0.412.

**Conclusions:** Thus simpler methods, using either M-mode or the difference in pulmonary-aortic ejection delay did not correlate well with dyssynchrony as measured by LVD. Sum D and also SLD (which is also measured with DTI) had the best correlation with LVD.

POSTER SESSION

**1026 Coronary Calcification for Detection of Subclinical Atherosclerosis**

Sunday, March 06, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 9:00 a.m.-10:00 a.m.

**1026-79 Racial Differences In The Presence And Severity Of Coronary Calcification In USA**

Khurram Nasir, Roger S. Blumenthal, Matthew J. Budoff, Johns Hopkins Medical Institutions, Baltimore

**Background & Methods:** Although cardiovascular risk factor levels are substantially different in Caucasians (CS), African American (AA) and Hispanics (HS) in the USA, the relative rates of coronary heart disease (CHD) in the 3 groups are not consistent with these differences. The objective of the study is to assess the differences in the prevalence and severity of coronary artery calcification (CAC) in these ethnic groups. Electron-beam tomography was performed in 11,282 asymptomatic men and women (CS=9742, AA=475, HS=1065) aged ≥ 45 years referred for CHD evaluation.

**Results:** In this study population (67% males, 52±8 years), CS was more likely to present with dyslipidemia and a family history of CHD (p<0.0001). On the other both AA and HS had a higher prevalence of smoking, diabetes and hypertension as compared to the CS counterparts (all p<0.001). After adjusting for age and risk factors, as compared to CS, AA men were least likely to have any CAC (OR: 0.49; 95% CI: 0.36-0.68) and severe CAC (≥400) with an OR of 0.35 (CI: 0.22-0.56) (table). In women, however AA had a significantly higher OR of any CAC and severe CAC (1.51; CI: 1.06-2.17 and 1.89; CI: 7.1-26, respectively) when compared with the CS women.

**Conclusions:** Our study results demonstrate significant difference in the presence as well as severity of CAC according to ethnicity. We also demonstrate that among men, AA were least likely to have CAC, whereas in women the most likely to have CAC among the different ethnic groups, respectively.

	Any (>0)	0.1-9.9	10-99.9	100-399.9	≥400
<b>MEN (7583)</b>					
Caucasian (n=6670)	1.00	1.00	1.00	1.00	1.00
Hispanics (n=630)	0.79 (0.62-1.02)	0.74 (0.53-1.04)	0.87 (0.65-1.16)	0.80 (0.58-1.11)	0.68 (0.48-0.96)*
AA (n=283)	0.49 (0.36-0.68)†	0.74 (0.49-1.12)	0.45 (0.30-0.67)†	0.45 (0.29-0.70)†	0.35 (0.22-0.56)†
<b>Women (3699)</b>					
Caucasian (n=3072)	0.75 (0.57-0.97)*	0.91 (0.64-1.27)	0.63 (0.43-0.91)*	0.62 (0.39-0.97)*	0.83 (0.51-1.36)
Hispanics (n=435)	1.51 (1.06-2.17)*	1.68 (1.08-2.63)*	1.62 (1.04-2.51)*	0.86 (0.47-1.56)	1.89 (1.08-3.29)*
AA (n=192)					

1026-80

**No Evidence for Increased Coronary Risk in an Unselected US-American Population Compared With a European (German) Unselected Population**

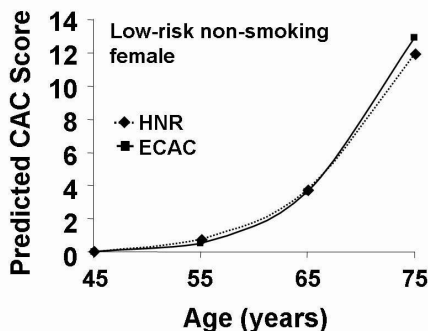
Axel Schmermund, Nils Lehmann, Lawrence F. Bielak, Andrea E. Cassidy, Patrick F. Sheedy, II, Susanne Moebus, Stefan Mohlenkamp, Andreas Stang, Klaus Mann, Stephen T. Turner, Karl-Heinz Jockel, Raimund Erbel, Patricia A. Peyser, University Clinic Essen, Essen, Germany, University of Michigan, Ann Arbor, MI

European investigators have reported overestimation of coronary artery disease (CAD) risk in European populations when applying the Framingham algorithm. We examined possible differences in coronary artery calcification (CAC) and risk factors in the general population (45 - 74 years) in Germany and US-America.

**Methods:** The *Heinz Nixdorf Recall* (HNR) study and the *Epidemiology of Coronary Calcification* (ECAC) study combined their data (subjects with no clinical CAD or stroke, n = 3,120 in HNR, n = 703 in ECAC). CAC was determined using electron-beam CT and the Agatston score in an identical fashion in both studies.

**Results:** The Framingham risk score was higher in HNR than ECAC (10.6 ± 7.6 vs. 9.3 ± 7.1, p < 0.001), and CAC scores were greater (median, 11.9 versus 2.4; p < 0.001). When subjects were matched on CAD risk factors, presence and quantity of CAC were similar. Risk factors significantly associated with CAC in both studies included: age, male sex, current and former smoking, systolic blood pressure, and non HDL-cholesterol. Using the same risk factor variables for modeling, the predicted CAC scores were comparable in both cohorts (Figure).

**Conclusions:** Despite differences in absolute risk in these large, unselected cohorts, risk factor associations with CAC were very similar. CAC provided an early measure of target organ damage associated with risk factor exposure. As opposed to studies concerning clinical endpoints, we could not demonstrate substantially higher CAC scores in the US-American cohort.



1026-81

**Corrected "Normal Values" for Subclinical Coronary Atherosclerosis in Truly Healthy Subjects With no Use of Cardiovascular Medication in a Large Population-Based Survey: Heinz Nixdorf Recall Study**

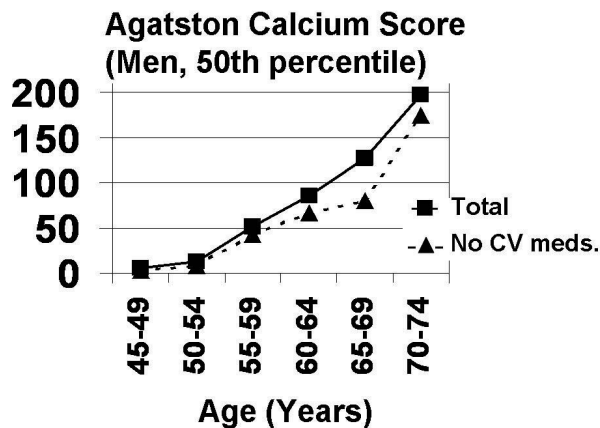
Axel Schmermund, Stefan Mohlenkamp, Sina Berenbein, Heiko Pump, Susanne Moebus, Ulla Roggenbuck, Andreas Stang, Rainer Seibel, Dietrich Gronemeyer, Karl-Heinz Jockel, Raimund Erbel, Heinz Nixdorf Recall Study Investigative Group, University Clinic Essen, Essen, Germany

The distribution of coronary artery calcification (CAC) scores in the unselected general population is not well defined, and the influence of cardiovascular medication (CV med) use has never been reported.

**Methods:** The *Heinz Nixdorf Recall* study is a population-based study which recruited a total of 4,814 unselected participants aged 45 - 74 years in the German Ruhr area. Medication use was meticulously recorded, allowing to delineate CAC scores in subjects with no CV meds. These were defined as antihypertensive, lipid-lowering, antidiabetic, and antiplatelet therapy. CAC scores were determined using electron-beam CT (EBCT) and the Agatston method.

**Results:** Of the 4,472 (92.9%) subjects with no history of coronary artery disease, the CAC score was available in 4,259 (95%) (2,017 men, 2,242 women). The 2,306 subjects (54%) with no CV meds were younger than subjects using CV meds (57 ± 7 vs. 62 ± 8 years, p < 0.001), whereas gender distribution was similar (47% males in both groups, p = 0.9). In all male 5-year age-groups except the highest (70 - 74 years of age), subjects with no CV meds had significantly lower CAC scores. In women, this was true in the age groups between 50 and 69 years. The figure shows median CAC scores in men with no CV meds compared with the total study group.

**Conclusions:** In subjects with no CV meds, there appeared to be a time-lag of up to 5 years before the same levels of CAC developed as in the total group. These lower values may be used as a reference for "truly healthy" individuals.



1026-82

**Association Of Traditional Risk Factors With Subclinical Coronary Atherosclerosis Varies In Different Ethnic Groups**

Raul D. Santos, Khurram D. Nasir, John A. Rumberger, Matthew J. Budoff, Joel B. Braunstein, Jose AM Carvalho, Paolo Raggi, Roger S. Blumenthal, Johns Hopkins Medical Institutions, Baltimore, MD, Lipid Clinic Heart Institute (InCor) University, São Paulo, Brazil

**Introduction:** The aim of the present study is to assess whether the association of traditional risk factors (RF) with coronary artery calcification (CAC) varies in a large asymptomatic white U.S. and Brazilian (BR) population, and may explain the difference in subclinical atherosclerosis observed in these groups.

**Methods & Results:** The study population consisted of 10,971 white males (20% BR) and 4,659 females (9.5% BR) who underwent electron beam tomography. For all ages except < 45 years old group, BR males were less likely to have any CAC compared to US males (45-54 yrs: OR 0.6, 55-64 yrs: 0.5 and ≥65 yrs:0.4, all p<0.0001). No such differences were observed in females. In the full multivariate model adjusting for all risk factors, US men had a higher odds of having any CAC (95% CI) with increasing age compared to BR men (45-55 yrs: 1.6, 55-64 yrs: 2.1, ≥65 yrs: 3.5, all<0.0001) as well with smoking status (1.5, p=0.004), whereas BR men had a higher association with diabetes (1.7, p=0.0005) compared to US men (table). On the other hand, Brazilian women had 3.7 higher odds of having any CAC with diabetes (p<0.0001) as compared to US females, whereas US females had 2.1 higher odds of any CAC with smoking as compared to BR females (p=0.006)

**Conclusions:** In this study increasing age and smoking were more strongly associated with presence of CAC in the US population, whereas diabetes was a stronger risk factor in the BR men and women. Further studies are needed to confirm our findings.

OR (95% CI) for CAC

	Age*	Hypertension	Smoking	Dyslipidemia	Diabetes		
	45-54 years	55-64 years	≥65 years				
US Male	3.2 (2.7-3.6)	8.1 (6.8-9.5)	23.6 (17.1-32.6)	1.5 (1.2-1.9)	1.7 (1.4-1.9)	1.5 (1.3-1.7)	1.3 (1.1-1.5)
Br Male	1.9 (1.5-2.3)	3.7 (2.9-4.8)	6.3 (4.2-9.2)	1.6 (1.3-1.9)	1.3 (1.1-1.6)	1.2 (0.9-1.3)	2.1 (1.4-2.8)
US Female	1.8 (1.3-2.3)	4.2 (3.1-5.6)	10.2 (7.4-14.1)	1.7 (1.2-2.2)	1.4 (1.2-1.7)	1.5 (1.2-1.8)	1.2 (1.0-1.6)
Br Female	1.3 (0.7-2.3)	3.3 (1.7-6.1)	7.0 (3.5-14.1)	1.8 (1.1-2.9)	1.1 (0.6-1.4)	1.4 (0.9-2.1)	3.7 (1.9-7.2)

\*Reference age <45 years

1026-83

**Metabolic Syndrome Provides Risk Stratification In Asymptomatic Men Considered Low Risk By Framingham Risk Estimation**

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**Background:** Individuals with metabolic syndrome are at increased risk for atherosclerosis. However it is unknown whether MS provides incremental risk information to the traditional risk factors of the Framingham algorithm for identifying coronary artery calcification (CAC) in asymptomatic men.

**Methods:** We studied 559 consecutive asymptomatic men (46±7 yrs) who presented for electron-beam tomography in San Paolo, Brazil. Participants were classified as low risk (<10% risk, n=259), intermediate risk (10-20%, n=163) and high risk (≥20% risk, n=42) based on Framingham risk estimation (FRE). MS was defined according the ATP III criteria. MS was present in 27% (n=125) of the study population.

**Results:** Compared to individuals with low risk, the odds for any CAC were higher with intermediate risk (OR=3.6, 95%CI=2.4-5.3, p<0.0001) and high risk (5.6, 3.3-9.4, p<0.0001) respectively. Prevalence of CAC was significantly higher in individuals with MS than without it (52% vs. 37%, p=0.002). Presence vs. absence of MS was associated with higher prevalence of CAC in low risk men (p=0.04, table), whereas the difference was non-significant on those with intermediate (p=0.4) and high-risk (p=0.9). The likelihood ratio statistics showed that the addition of MS to FRE contributed significantly in identifying CAC only among low risk men (p<0.001).

**Conclusions:** Our study findings suggest that MS provides additional risk stratification among low-risk individuals. Further studies are needed to confirm our findings.

Low-risk	MS	No MS	P value
Low-risk	36%	23%	0.04
Intermediate-risk	56%	56%	0.9
High-risk	73%	73%	0.4

**1026-84 Gender Differences in Risk Factors for Subclinical Coronary Atherosclerosis: Evaluation by Electron Beam Tomography**

Harvey S. Hecht, Eyad AlHaj, TJ Matarazzo, Patricia Freidmann, Beth Israel Medical Center, New York, NY

**Background:** Gender differences may affect the contribution of conventional risk factors to subclinical coronary atherosclerosis.

**Methods:** 3912 consecutive asymptomatic patients, 2692 men (mean age 52.1±11.4 years) and 1220 women (mean age 55.5±11.3 years), who underwent electron beam tomography coronary artery calcium (CAC) plaque imaging were analyzed.

**Results:** CAC (scores>0) was present in 55.3% of the men and 35.7% of the women (p<0.0001). The presence of CAC in relation to each risk factor is shown in the Table.

	Hypertension	Diabetes	Increased Cholesterol	BMI>25	BMI>30	Smoking	Family History
Men	69.5%	83.2%	65.2%	54.6%	55.9%	60.9%	55.6%
Women	46.8%	51.7%	47.9%	39.7%	40.1%	36.9%	45.9%

All but BMI, smoking in women and family history in men were associated with significantly higher CAC than patients without the risk factor.

Multivariate analysis revealed the independent predictors of CAC in men were: age/10 years (OR 2.75, p<0.0001), ↑cholesterol (OR 1.63, p<0.0001), diabetes (OR 2.91, p=0.0003, ↑BP (OR 1.39, p=0.0086) and premature family history (OR 1.42, p=0.0034). In women, independent predictors were: age/10 years (OR 2.66, p<0.0001), ↑cholesterol (OR 1.88, p<0.0001), Premature family history (OR 1.88, p<0.0001), and BMI ≥ 25 (OR 1.36, p=0.02).

**Conclusions:** 1) Age, cholesterol and premature family history were independent predictors of subclinical atherosclerosis in both men and women. 2) Hypertension and diabetes were independently predictive only in men and BMI≥25 was predictive only in women; smoking was not predictive in either group. 3) Modifications of risk stratification that incorporate gender differences in risk factor importance should be considered.

**1026-85 Smoking Does Not Contribute to Subclinical Coronary Atherosclerosis in Middle Aged Asymptomatic Women**

Eyad AlHaj, Patricia Friedmann, TJ Matarazzo, Harvey S. Hecht, Beth Israel Medical Center, New York, NY

**Background:** The relative importance of risk factors may be gender related. Smoking within the past 30 days is considered a major risk factor in the Framingham Risk Score irrespective of gender.

**Methods:** To investigate the contribution of cigarette smoking in women to the development of subclinical coronary atherosclerosis, 1427 consecutive asymptomatic women (mean age 55.5±11.3 years) who underwent electron beam tomography calcified coronary plaque imaging were evaluated. Smoking categories were: never smoked (N), current smokers (C), former smokers (F), and ever smoked (F+C).

**Results:** Coronary calcium (calcium score >0) was present in 35 % of N, 32% of C, 39 % of F, and 37% of F+C (p=NS). Stratification of the coronary calcium scores according to smoking categories is shown in the Table, and demonstrates the absence of a relationship between smoking categories and the calcified plaque burden.

Smoking and Calcified Coronary Plaque

Calcium Scores		0	1-9	10-100	101-400	>400
	n	919	127	224	169	85
N	1097	65.0%	7.8%	13.4%	8.8%	5.0%
F	231	61.0%	5.6%	15.2%	14.7%	3.5%
C	99	67.7%	9.1%	6.1%	13.1%	4.0%
F+C	230	63.0%	6.7%	12.4%	14.2%	3.6%

In a multivariate analysis of smoking, age, family history, hypertension, BMI, diabetes and cholesterol disorders, smoking did not independently contribute to the presence of coronary calcium.

**Conclusions:** 1) Smoking did not contribute to subclinical atherosclerosis in asymptomatic middle aged women; 2) Further evaluation of the gender specific effects of smoking as a major risk factor may be indicated.

**1026-86 Correlation Between Coronary Calcification and Endothelial Dysfunction in Asymptomatic Subjects at Risk of Coronary Artery Disease**

Rosario Rossi, Vincenzo Turco, Carlo Ratti, Guido Ligabue, Renato Romagnoli, Maria G. Modena, University of Modena and Reggio Emilia, Modena, Italy

**Background:** The amount of calcium in the coronary arteries correlates with the extent of atherosclerosis. Endothelial dysfunction is recognized to be an early event in atherogenesis.

**Aim:** We sought to evaluate the correlation between endothelial function and the presence and extent of coronary artery calcium (CAC).

**Methods:** The study was performed in 213 asymptomatic, middle-aged (45 to 60 years old; mean age: 53 ± 6) subjects (25.3% men), who were referred at our institution for CAC screening. All enrolled individuals were considered to be at above-average risk for coronary disease because of the presence of coronary risk factors. Multislice computed tomography was used to detect and quantify CAC, and high resolution ultrasound to measure flow-mediated vasodilation (FMD) in the brachial artery. Subjects were divided into three groups according to FMD tertiles.

**Results:** Hypertension and hypercholesterolemia were present in the 50.7% and 46.0% of the population, respectively; 41.3% of the individuals were current smokers and 11.7% had diabetes. CAC was detected (CAC score > 0) in 151 subjects (70.9% of the entire population); the mean CAC score resulted 135 ± 385. Mean FMD was 5.1 ± 4.5%. There was a significant correlation between CAC score and FMD (r = -0.54; p<0.0001). CAC score increased in a graded fashion with decreasing FMD (422 ± 398 in subjects located in the lowest tertile [FMD < or = 4.3%]; 133 ± 344 in the intermediate tertile [FMD from 4.4 to 5.5%], and 77 ± 299 in the higher tertile [FMD > or = 5.6]; p<0.0001 for trend). There were no significant differences between groups regarding age and presence of coronary risk factors.

**Conclusions:** In this population of middle-aged, asymptomatic subjects, elevated CAC score correlated with impaired endothelial function. These data confirm a significant role for endothelial dysfunction in the coronary atherogenic process.

POSTER SESSION

**1027 Cardiovascular Magnetic Resonance: New Applications of Phase Velocity Imaging and Congenital Heart Disease**

Sunday, March 06, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 9:00 a.m.-10:00 a.m.

**1027-71 Phase Contrast Magnetic Resonance Imaging of the Pulmonary Artery Predicts Invasive Pulmonary Hemodynamic Measurements**

Javier Sanz, Roxana Sulica, Santo Dellegrottaglie, Martin Goyenechea, Paola Kuschnir, Juan F Viles-Gonzalez, Teresa Rius, Valentin Fuster, Sanjay Rajagopalan, Michael Poon, The Zena and Michael A Wiener Cardiovascular Institute, Mount Sinai School of Medicine, New York, NY

**Background:** Right heart catheterization (RHC) is the gold standard for the diagnosis of pulmonary arterial hypertension (PAH). Phase-contrast magnetic resonance imaging (PC-MRI) allows for the noninvasive characterization of arterial flow profiles. We hypothesized that pulmonary artery (PA) flow measurements obtained with PC-MRI correlate with RHC parameters.

**Methods:** In 55 patients with known or suspected PAH (age 47±14 years) PC-MRI and RHC (mean interval 2.2±4.1 days) were performed. PC-MRI measurements were obtained perpendicular to the PA trunk using a retrospectively ECG-gated, breath-hold, velocity-encoded sequence in a 1.5T system. PA mean area (cm<sup>2</sup>), acceleration time (msec) and peak and mean velocities (cm/sec) were measured from PC-MRI. Mean PA pressure (mmHg) and pulmonary vascular resistance (Wood units) were obtained from RHC.

**Results:** PAH (mean pulmonary pressure at rest >25 mmHg) was confirmed in 39 (71%) patients. Correlation coefficients between RHC and PC-MRI variables are shown in table. Receiver-operator curve analysis of mean PA velocity in predicting PAH revealed a sensitivity of 95% and specificity of 81% for the detection of PAH using a best cut-off value of 12.2 cm/sec (area under the curve 0.92, p<0.001).

**Conclusion:** Pulmonary PC-MRI measurements correlate with RHC-derived hemodynamic parameters. PA mean velocity can reliably detect the presence of PAH. Thus, PC-MRI may be a useful non-invasive imaging technique for the early diagnosis of PAH.

Correlations between phase contrast and right heart catheterization measurements

	Mean velocity	Peak velocity	Mean area	Acceleration time
Mean pulmonary pressure	r=-0.73 (p<0.0001)	r=-0.35 (p=0.008)	r=0.66 (p<0.0001)	r=-0.37 (p=0.005)
Pulmonary vascular resistance	r=-0.75 (p<0.0001)	r=-0.45 (p=0.001)	r=0.56 (p<0.0001)	r=-0.40 (p=0.002)

**1027-72 MRI Assessment of Myocardial Elasticity Using Displacement Imaging and Phase-Contrast Velocity Mapping**

Han Wen, Eric Bennett, Jonathan F. Plehn, National Heart, Lung and Blood Institute, National Institutes of Health, Bethesda, MD

**Background:** Approximately half of patients experiencing congestive heart failure present with a normal left ventricular ejection fraction. Perturbations in material properties affecting ventricular pressure/volume relationships are likely responsible for this "stiff heart syndrome" yet noninvasive tools permitting the accurate assessment of myocardial elasticity are extremely limited.

**Methods and Results:** We developed an MRI-based technique to examine regional left ventricular stress/strain relationships by incorporating displacement encoding with stimulated echoes (DENSE) and phase velocity mapping and compared regional elastic moduli (EM)

and viscous delay time constants (VDTs) with immediate post-mortem direct strain gauge measurements in 17 normal dogs and two dogs 4 weeks following anterior myocardial infarction. We also assessed technique feasibility in two normal humans. Consistent with known regional anisotropic properties, EMs by MRI were significantly greater in papillary muscle columns than lateral wall and septal locations ( $7.59 \pm 1.65$  versus  $3.40 \pm 0.87$  versus  $2.55 \pm 0.93$  kPa,  $p < 0.0001$ ) and were similar in lateral and septal locations to direct strain gauge measurements ( $3.78 \pm 0.93$  and  $2.96 \pm 0.88$  kPa, respectively for strain gauge,  $p = ns$  for both versus MRI). MRI-determined VDTs were similar in the three regions (VDTC =  $1.2 \pm 12.4$  versus  $3.0 \pm 7.3$  versus  $4.2 \pm 5.8$  ms,  $p = ns$ ) and did not differ from lateral and septal wall strain gauge measurements (VDTC =  $3.1 \pm 0.4$  and  $4.6 \pm 1.9$  ms,  $p = ns$  for both versus MRI). In the two dogs at 4 weeks post infarction, affected regions maintained their thickness but displayed markedly increased stiffness (EM 8 to 20 kPa) compared to normal regions (EMs less than 1.5 kPa). Stress/strain measurements obtained in two normal volunteers demonstrated similar regional distribution and progressive increases in EM and reductions in VDTC from early to mid diastole (EM =  $0.65 \pm 0.29$  to  $2.21 \pm 1.35$  kPa from early to mid diastole, VDTC =  $10.6 \pm 1.3$  to  $3.8 \pm 1.7$  ms).

**Conclusions:** Noninvasive, regional assessment of myocardial stiffness using MRI-based DENSE and phase velocity mapping techniques is accurate in a canine model and appears to be feasible in humans.

**1027-73 Magnetic Resonance Delayed Enhancement for the Detection of Fibrous Tissue in Postoperative Pediatric Patients With Various Forms of Congenital Heart Disease**

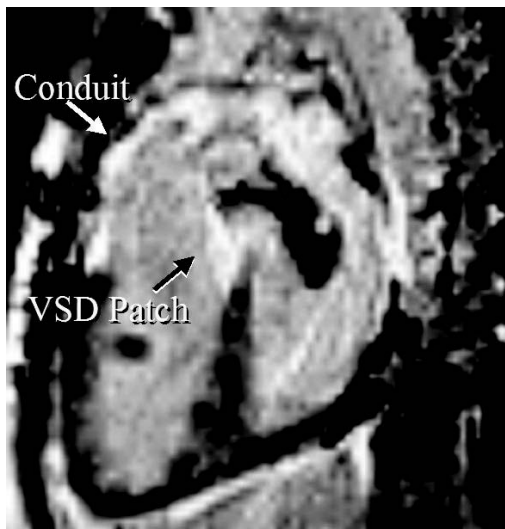
Matthew A. Harris, Susan Ghods, Paul M. Weinberg, Mark A. Fogel, The Children's Hospital of Philadelphia, Philadelphia, PA

**Background:** Because endothelialization occurs on conduits and patches, we hypothesized that delayed enhancement magnetic resonance (MR) imaging should identify these areas and other fibrous tissue such as valve leaflets and their annuli.

**Methods:** We retrospectively reviewed myocardial viability studies. Ages ranged from 4 months to 19 years. Studies were reviewed for the presence of delayed enhancement involving conduits, ventricular septal defect (VSD) patches, valve leaflets and their annuli. Group 1 (n=14) diagnoses included tetralogy of Fallot, transposition with VSD, truncus arteriosus, and atrioventricular canal. Group 2 patients who had never undergone surgery-involving placement of conduits or VSD patches were used as controls (n=12).

**Results:** In Group 1, delayed enhancement of the conduit occurred in 11/14 patients (79%), VSD patch in 7/14 patients (50%), and involvement of the valve leaflets or annuli in 11/14 patients (79%). 2/14 patients (14%) did not have any delayed enhancement. In Group 2 there was no evidence of delayed enhancement in the region of the outflow tracts, and 3/12 (25%) patients experienced delayed enhancement involving the tricuspid valve.

**Conclusion:** MR delayed enhancement can identify regions of fibrous tissue formation on conduits and VSD patches in postoperative pediatric patients with various forms of congenital heart disease. This information may be helpful for understanding and tracking the development of fibrous tissue in surgically reconstructed hearts.



3-year-old with Truncus Arteriosus

**1027-74 Myocardial Infarction Due To Coronary Embolism In Patients With Patent Foramen Ovale Assessed By Cardiac Magnetic Resonance Imaging**

Nico Merkle, Thorsten Nusser, Jochen Wöhrle, Matthias Kochs, Vinzenz Hombach, Olaf Grebe, Universitätsklinik Ulm, Innere Medizin II, Ulm, Germany

Paradoxical embolism in patients with Patent foramen ovale (PFO) is supposed to be a possible cause for stroke when there is no other obvious reason. It is not clear to what extent there is a relation to myocardial infarction but there is some data suggesting that coronary arteries are affected in about 5-10% of all paradoxical embolism. The advantage of cardiac magnetic resonance imaging (CMRI) is the non-invasive assessment of even small myocardial infarction presenting as pathological late-enhancement.

**Methods:** 95 patients aged from 13 to 70yrs (mean 48yrs, 59% male) with cerebral ischemia and PFO in transeophageal echocardiography were examined by contrast enhanced CMRI (1.5 T Intera CV, Philips) before percutaneous closure of the PFO. Infarction-like myocardial late-enhancement was seen in 9 patients (9,5%). Only one of those had coronary artery disease (CAD) in coronary angiography, so we suggest that in 8 patients (mean 51yrs, 63% male) coronary embolism was the reason for myocardial infarction. Infarction size varied from small subendocardial lesions to large defects of transmural extent. Only 3 patients had a history of acute chest pain, and only 2 of them showed infarction-like changes in ECG.

The ejection fraction of the left ventricle was significantly lower in patients with myocardial scars (mean 60,8% vs. 69,6%,  $p = 0,03$ ).

**Conclusion:** CMRI is a powerful non-invasive tool in the assessment of myocardial infarction in patients with PFO due to coronary embolism that remains undiscovered in 63%.

**1027-75 Longitudinal Myocardial and Transmitral Velocities by Phase-Contrast Cardiac Magnetic Resonance Imaging: Correlation with Doppler Echocardiography**

Sriram Padmanabhan, Vandana Sachdev, Li-Yueh Hsu, Sidenko Stanislaw, Andrew E. Arai, National Institutes of Health/NHLBI/LCE, Bethesda, MD

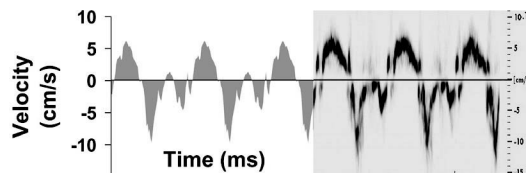
**Background:** Longitudinal myocardial velocities can assess regional function and viability. Phase-contrast Magnetic Resonance Imaging (PC-MRI) can provide quantifiable velocities but has not been correlated with Tissue Doppler Imaging (TDI) velocities by echocardiography. The purpose of this study is to validate longitudinal myocardial and transmitral velocities by PC-MRI with TDI.

**Method:** We recruited 17 patients with myocardial infarction (MI) and 9 volunteers. MRI and echo were done within 12 hours of each other. Basal myocardial and transmitral velocities were measured by PC-MRI (temporal resolution 28 msec). TDI of myocardial systolic (S'), early (E') and late diastolic (A'), and transmitral E and A were measured. Results are mean  $\pm$  SD.

**Results:** Mean age was  $62 \pm 11$ . Ejection fraction was significantly different between the normal and MI groups ( $60 \pm 4$  vs.  $43 \pm 7$ ,  $p < 0.001$ ). MRI velocities ranged from 112 to -15 cm/s. It showed strong linear correlation with echo velocities ( $R = 0.98$ ,  $p < 0.001$ ). Bland-Altman analysis showed that MRI overestimated longitudinal velocities by  $0.5 \pm 3$  cm/s in all subjects, by  $0.2 \pm 2$  cm/s in MI patients, and by  $1 \pm 4$  cm/s in normal volunteers. MRI underestimated trans-mitral flow by  $10.3 \pm 10$  cm/s.

**Conclusions:** High temporal resolution PC-MRI is feasible. Myocardial and transmitral velocities obtained by PC MRI strongly correlates with velocities by echo Doppler.

**Fig. Longitudinal myocardial velocity by PC-MRI (left) and TDI (right) in the infero-septum of a normal volunteer**



**1027-76 Validation of the Relationship Between Pulse Wave Velocity and Arterial Stiffness in End Stage Renal Failure Using Cardiovascular Magnetic Resonance Imaging**

Patrick B. Mark, Gang Gao, John E. Foster, Kevin G. Blyth, Henry J. Dargie, Alan G. Jardine, Western Infirmary, Glasgow, United Kingdom

**Background** Pulse wave velocity (PWV), measured by Doppler, is an indirect measure of arterial stiffness, and is a marker of poor cardiovascular outcome in end stage renal failure (ESRF). We studied the relationship between PWV, measured by cardiovascular magnetic resonance imaging (CMR), aortic distensibility (a direct measure of arterial stiffness) and LV dimensions in patients with ESRF.

**Methods** 25 patients (16 male; median age 53, range 34-62) with ESRF underwent CMR (1.5T Siemens Sonata). LV and aortic dimensions were assessed from cine loops. Aortic blood flow was measured using a flow sensitive fast low angle shot sequence. PWV was calculated from distance and time delay in flow between 2 points along the aorta using in house software (CardioWarp) to detect aortic contours (figure below). Ascending aortic distensibility was calculated from change in cross sectional aortic area and brachial pulse pressure.

**Results** Mean aortic distensibility was  $2.8 \times 10^{-3} \pm 0.13 \times 10^{-3} \text{Hg}^{-1}$  and PWV was  $6.6 \pm 2.0$  m/s. There was a significant, age independent, negative correlation between ascending aortic distensibility and PWV ( $R = -0.58$ ,  $p < 0.01$ ) but no correlation between either aortic distensibility or PWV and LV dimensions. There was a non significant correlation between age and PWV ( $R = 0.355$ ,  $p = 0.08$ ).

**Conclusions** PWV does inversely correlate with aortic distensibility and therefore represents a useful indirect measure of arterial stiffness. The prognostic value of CMR derived PWV in patients with ESRF merits further study.



1027-77

### Relationship Between Resting Heart Rate and Aortic Wave Velocity in Apparently Healthy Individuals

Ross Arena, James Arrowood, Ding-Yu Fei, Kenneth Kraft, Virginia Commonwealth University, Richmond, VA

**Background:** Resting heart rate (RHR) has demonstrated diagnostic and prognostic value in a number of previous investigations. Amongst the diagnostic relationships, several studies have reported a significant association between various measures of arterial stiffness and RHR. The purpose of the present investigation was to assess the relationship between RHR and a newly developed measure of aortic wave velocity (AWV) via magnetic resonance imaging.

**Methods:** Two hundred and fourteen apparently healthy subjects (114 male/ 100 female) participated in this study. Mean age of the group was 48.5 ( $\pm 14.9$ ) years. Resting heart rate, in beats per minute (BPM), was obtained in the seated position via electrocardiography. Aortic wave velocity, in meters per second (m/s), was assessed in the descending thoracic aorta using a magnetic resonance imaging technique developed by our group. We used a Pearson Product Moment Correlation to evaluate the relationship between RHR and AWV in the overall group. After partitioning subjects into RHR subgroups, (<60, 60-74, >74 BPM), we used one-way analysis of variance and Tukey's honestly significant difference to assess differences in age and AWV.

**Results:** Mean RHR and AWV were 64.5 ( $\pm 11.7$ ) BPM and 5.8 ( $\pm 1.9$ ) m/s, respectively. These two variables were significantly correlated with one another ( $r = 0.22$ ,  $p = 0.001$ ). The number of subjects in the <60, 60-74 and >74 RHR subgroups were 76, 97 and 41 respectively. Mean age amongst the three subgroups [<60: 48.4 ( $\pm 13.7$ ), 60-74: 50.0 ( $\pm 15.6$ ), >74: 45.4 ( $\pm 15.3$ )] was not significantly different. Mean AWV in the <60, 60-74, and >74 RHR subgroups was 5.2 ( $\pm 1.6$ ), 6.1 ( $\pm 2.0$ ), and 6.3 ( $\pm 1.9$ ) m/s, respectively. Aortic wave velocity in the <60 RHR subgroup was significantly lower than that in both the 60-74 and >74 RHR subgroups ( $p = 0.01$ ).

**Conclusion:** The results of the present study are consistent with previous reports demonstrating a relationship between arterial stiffness and RHR, helping to validate our newly developed AWV measurement via magnetic resonance imaging. Additionally, these results further illustrate the value of RHR in reflecting other markers of cardiovascular health.

1027-78

### Tissue MR Imaging of Subacute Myocardial Infarction: Correlation With B-Type Natriuretic Peptide and Tissue Doppler Imaging

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**Background:** B-type natriuretic peptide (BNP) is an amino acid protein released from the cardiac ventricles in response to myocyte stretch. BNP has been correlated to left ventricular (LV) filling pressures in patients with LV dysfunction and has been used to improve management of these patients. Combining Doppler assessed early diastolic mitral flow velocity (E) with early diastolic mitral annular velocity (Ea) has been correlated with both LV pressures and BNP. Phase-contrast magnetic resonance (MR) imaging allows velocity encoding of both moving structures (tissue MR Imaging) and blood. Therefore, the purpose of the present study was to study whether tissue MR Imaging assessed E/Ea correlates with BNP.

**Methods:** 14 patients in the subacute phase ( $5.9 \pm 2.7$  days) of Q-wave myocardial infarction (mass index:  $83 \pm 14$  g/m<sup>2</sup>, ejection fraction:  $44 \pm 12$  %) underwent consecutive measurement of mitral inflow and mitral annular velocities with Doppler and phase-contrast MR imaging. The data were correlated with BNP.

**Results:** There was a strong relation between MR ( $12.5 \pm 6.3$ ) and Doppler ( $12.6 \pm 5.6$ ) assessed E/Ea ( $r=0.89$ ,  $P<0.0001$ ) and between MR ( $1.8 \pm 0.8$ ) and Doppler ( $1.5 \pm 0.8$ ) assessed E/A ( $r=0.92$ ,  $P<0.0001$ ). BNP ranged from 39.5 to 2380 pg/ml. E/A related strongly to BNP (MR:  $r=0.72$ ,  $P=0.004$  and Doppler:  $r=0.66$ ,  $P=0.014$ ). Best relation was found between E/Ea and BNP (MR:  $r=0.74$ ,  $P=0.002$  and Doppler:  $r=0.88$ ,  $P<0.0001$ ).

**Conclusions:** Tissue MR Imaging has the ability to measure E/Ea. Tissue MR Imaging assessed E/Ea correlates with BNP in patients with subacute myocardial infarction.

## 1028 MIBG Imaging of Cardiac Sympathetic Nervous Activity

Sunday, March 06, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 9:00 a.m.-10:00 a.m.

1028-67

### Angiotensin Converting Enzyme Inhibitors Improves Myocardial Adrenergic Innervation Disturbances in Normotensive Patients With Diabetes Type II

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**Background:** Myocardial sympathetic dysinnervation is frequently observed in patients (pts) with diabetes mellitus even in the absence of any heart disease. Cardiac scintigraphy with I 123 -Meta-iodobenzylguanidine (I 123 -MIBG) was used to assess the effect of perindopril - an angiotensin converting enzyme (ACE- I) - on myocardial adrenergic innervation in normotensive pts with diabetes type II.

**Methods:** We studied 40 normotensive pts (22 women, aged  $57 \pm 8$  years,) with diabetes type II, a normal echocardiogram and a Thallium201 myocardial perfusion study. None had any other disease that may have affected myocardial adrenergic innervation. Perindopril was given to 20 pts (4 mg/day) for 6 months, while the rest received placebo. Before entering the study and at 6 months under perindopril therapy, all pts underwent planar and SPECT myocardial imaging of the heart after intravenous infusion of 5mCi I 123-MIBG. Heart to mediastinum ratio (H/M) was used for quantitative assessment of adrenergic innervation, 10 minutes and 4 hours after drug infusion, while SPECT scintigraphy evaluated the regional distribution of adrenergic activity.

**Results:** At baseline, the H/M ratio at 10 min and 4 hours was  $1.62 \pm 0.3$  and  $1.5 \pm 0.2$  respectively; which significantly improved after the 6-month treatment with perindopril ( $1.88 \pm 0.4$  and  $1.8 \pm 0.2$  respectively,  $p<0.05$  for both). During SPECT scintigraphy, 12 pts (80%) revealed severe regional myocardial adrenergic innervation defects. All had defects in the inferior and lateral wall, 8 had additional defects in the anterior wall and 6 in the septal wall. There was a marked improvement in myocardial adrenergic innervation after 6 months of therapy, mostly in the anterior and septal walls. No significant changes were observed in the control group. Systolic blood pressure remained unchanged before and after treatment.

**Conclusions:** The administration of ACE- I in normotensive pts with diabetes type II results in a significant improvement of the left ventricular adrenergic innervation abnormalities, independently of its blood pressure effect. Further studies are required to establish the preventative value of ACE- I in cardiovascular complications of diabetes.

1028-68

### Myocardial Iodine-123-Metaiodobenzylguanidine Scintigraphy Can Predict Left Ventricular Functional Reserve in Patients With Nonobstructive Hypertrophic Cardiomyopathy

Satoshi Isoe, Hideo Izawa, Mitsunori Iwase, Satoru Ohshima, Kiyoyasu Yamada, Mamoru Nanasato, Toshihisa Hirai, Akitada Ando, Kohzo Nagata, Katsuhiko Kato, Toyooki Murohara, Mitsuhiro Yokota, Nagoya University Graduate School of Medicine, Nagoya, Japan

**OBJECTIVES:** We investigated whether an assessment of cardiac sympathetic nervous activity by <sup>123</sup>I-metaiodobenzylguanidine (MIBG) myocardial scintigraphy might provide a sign of abnormal left ventricular (LV) functional reserve in response to exercise-induced  $\beta$ -adrenergic stimulation in patients with nonobstructive hypertrophic cardiomyopathy (HCM).

**BACKGROUND:** Little is known regarding the relation between LV functional reserve in response to exercise and cardiac sympathetic nervous activity in patients with HCM.

**METHODS:** Thirty HCM patients underwent MIBG scintigraphy and echocardiography at rest and subsequent biventricular cardiac catheterization at rest and during dynamic exercise. LV pressures were measured using a micromanometer-tipped catheter system. Early and delayed MIBG images were quantified as a heart-to-mediastinum ratio (HMR) and washout rate. Patients were divided into 2 groups according to the delayed MIBG HMR: group I consisted of 12 patients with a delayed HMR  $\leq 1.8$  and group II had 18 patients with a delayed HMR  $> 1.8$ . Plasma levels of brain natriuretic peptide and norepinephrine were also measured.

**RESULTS:** Both the percent (%) increase from rest to exercise in LV isovolumic contraction (LV dP/dt<sub>max</sub>) and the % shortening of LV pressure half-time (T<sub>1/2</sub>) as an index of isovolumic relaxation were significantly less in group I than in group II ( $p < 0.005$ , respectively). Significant linear correlation was observed between MIBG parameters (early HMR, delayed HMR, and washout rate) and the % increase in LV dP/dt<sub>max</sub> ( $p < 0.05$ , respectively). Significant linear correlation was observed between MIBG parameters and the % shortening in T<sub>1/2</sub> ( $p < 0.05$ , respectively). Plasma norepinephrine levels were significantly higher in group I than in group II ( $p < 0.01$ ), whereas plasma brain natriuretic peptide levels were comparable in the 2 HCM groups.

**CONCLUSIONS:**  $\beta$ -Adrenergic enhancement of LV function during exercise may depend on the extent of cardiac sympathetic nervous innervation in HCM patients. Resting myocardial MIBG scintigraphy can noninvasively evaluate the LV functional reserve in response to exercise in patients with nonobstructive HCM.

1028-69

**Relationship Between Myocardial <sup>123</sup>I-MIBG Findings and Myocardial Contractile Reserve in Patients With Mild to Moderate Dilated Cardiomyopathy**

Satoru Ohshima, Satoshi Isobe, Hideo Izawa, Kiyoyasu Yamada, Akitada Ando, Katsuhiko Kato, Kohzo Nagata, Toyoaki Murohara, Mitsuhiro Yokota, Nagoya University Graduate School of Medicine, Nagoya, Japan

**Background:** The relationship between cardiac sympathetic nervous activity and myocardial contractile reserve in patients with dilated cardiomyopathy (DCM) still remains to be elucidated.

**Objectives:** We aimed to clarify the relationship between iodine-123-metiodobenzylguanidine (MIBG) findings and myocardial contractile reserve in response to atrial pacing stimulation in mild to moderate DCM.

**Methods:** Twenty-four DCM patients (mean LVEF 41 ± 7%) with sinus rhythm underwent echocardiography, biventricular cardiac catheterization, and myocardial MIBG scintigraphy. In cardiac catheterization, left ventricular (LV) pressures were measured using a micromanometer-tipped catheter. The myocardial contractile function [LV isovolumic contraction (LV dP/dt max)] was determined at rest and during atrial pacing. Myocardial MIBG accumulation was quantified as a heart-to-mediastinum ratio (HMR).

**Results:** A significant correlation was observed between the delayed MIBG HMR and the percent change in LV dP/dt max from baseline to the maximum or critical heart rate (r = 0.64, p < 0.001). The biphasic or flat pattern of change in LV dP/dt max (a worsening change) was more frequently observed in DCM patients who showed a delayed HMR of < 1.7 (group A: 10 patients) than in those who showed one of ≥ 1.7 (group B: 14 patients) [8/10 patients (80%) vs. 2/14 patients (14%), p < 0.001]. Plasma norepinephrine levels were significantly higher in group A than in group B (p < 0.05).

**Conclusions:** Abnormal myocardial <sup>123</sup>I-MIBG accumulation is related to a reduced myocardial contractile reserve in response to atrial pacing stimulation in patients with mild to moderate DCM. Myocardial MIBG scintigraphy may be useful in noninvasively evaluating the degree of impaired myocardial function and clinical outcome in patients with mild to moderate DCM.

1028-70

**Differences in Cardiac Sympathetic Nerve Dysfunction in the Dilated Phase of Hypertrophic Cardiomyopathy versus Idiopathic Dilated Cardiomyopathy**

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**Background:** Left ventricular (LV) systolic dysfunction and dilatation, with development of treatment-resistant heart failure, occur both in the dilated phase of hypertrophic cardiomyopathy (DHCM) and in idiopathic dilated cardiomyopathy (DCM). However, it is unknown whether cardiac sympathetic nerve function differs between DHCM and DCM. The aim of the study was to evaluate global and regional differences in I-123 metaiodobenzylguanidine (MIBG) myocardial scintigraphy in patients with DHCM and DCM.

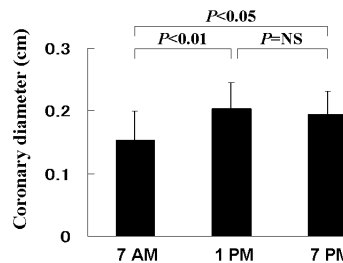
**Methods:** We performed I-123 MIBG scintigraphy in 21 patients with LV systolic dysfunction and dilatation (9 patients with DHCM and 12 patients with DCM) and in 13 age-matched controls. Regional uptake and washout rates were calculated from single photon emission computed tomographic images divided into 20 segments.

**Results:** No significant differences existed with respect to gender, age and echocardiographic findings between DHCM and DCM. The global washout rate was higher in DHCM than DCM (29.6±4.1% vs. 21.1±4.1%, p<0.01). In DHCM, regional early uptake was reduced significantly in the anteroseptal and posterolateral walls. In contrast, in DCM regional early uptake was significantly reduced in the posterolateral wall but not in the anteroseptal wall. Regional washout rate increased heterogeneously in the apex and lateral wall predominantly in DHCM. In contrast, a heterogeneous increase in regional washout rate was not found in DCM. **Conclusions:** These results suggest that cardiac sympathetic nerve abnormalities may differ between DHCM and DCM. Cardiac sympathetic nerve hyperactivity appears to be distributed heterogeneously in patients with DHCM, as compared with a more homogeneous distribution in the patients with DCM.

**Methods:** We studied 10 healthy volunteers (7 men, mean age; 30.4±2.6 years). All subjects underwent serial transthoracic echocardiography (HDI 5000, P12 probe, Philips) to evaluate coronary diameter and flow velocity at 7 AM, 1 PM and 7 PM. In each different occasion, we measured coronary diameter and flow velocity in the left anterior descending artery.

**Results:** Coronary diameter was smallest at 7 AM and the largest at 1 PM [0.15±0.05cm at 7 AM, 0.20±0.04cm at 1 PM, and 0.19±0.04cm at 7 PM, (p<0.01: 7 AM vs. 1 PM, 7 AM vs. 7 PM)]. Coronary flow velocity was 17.9±5.3cm/s at 7 AM, 13.3±3.4cm/s at 1 PM, and 15.4±6.1cm/s at PM (p<0.05: 7 AM vs. 1 PM, 7 AM vs. 7 PM).

**Conclusions:** We showed the circadian variation of coronary artery diameter and flow velocity in healthy volunteers. Coronary diameter was smallest, and coronary flow velocity was highest in the morning.



1052-64

**Non-Invasive Assessment of Coronary Flow Velocity Pattern With Transthoracic Doppler Echocardiography After Primary Angioplasty for Acute Myocardial Infarction: An Early Predictor of Persistent Left Ventricular Dysfunction**

Aliocha Scheuble, Eric Brochet, Marc Faraggi, Dominique Himbert, Jean-Michel Juliard, Dominique Le Guludec, Ph. Gabriel Steg, Alec Vahanian, Laurent J. Feldman, Bichat University Hospital, Paris, France

**Background:** Intracoronary Doppler guidewire studies have shown that patients with an early systolic retrograde flow (ESRF) and a short diastolic deceleration time (DDT) after primary angioplasty for acute myocardial infarction have severely impaired microcirculatory perfusion, resulting in poor recovery of left ventricular (LV) function. Transthoracic Doppler echocardiography (TDE) allows non-invasive assessment of coronary flow velocity in the left anterior descending coronary artery. We studied the relationship between LV function recovery and coronary flow velocity parameters obtained with TDE early after primary angioplasty for acute myocardial infarction.

**Methods:** 24 consecutive patients who underwent successful primary coronary stenting for ≤ 12-hour anterior myocardial infarction were studied. Coronary flow velocity pattern and adenosine-induced (140 microgram/kg/min, 5 min iv perfusion) coronary flow velocity reserve (CVR) were measured using a high frequency TDE probe (7MHz, 7V3C Acuson/Siemens) 24 hours and 3 days after primary angioplasty, respectively. LV function recovery was defined as >20% improvement of the indexed wall motion score in the infarct area between 2 echocardiograms performed 24 hours and 8 weeks after myocardial infarction. Patients were divided into group A (11 patients with LV function recovery) and group B (13 patients without LV function recovery). Radionuclide LV ejection fraction was measured at 8 weeks.

**Results:** Patients in group B had a lower LV ejection fraction at 8 weeks (39 ±9% vs 52 ±11%, p=0.003), a higher incidence of ESRF (77% vs 23%, p=0.045) and a shorter DDT (341 ±365 ms vs 942 ±611 ms, p=0.007) at 24 hours, and a marginally lower CVR (2.1 ±0.6 vs 1.8 ±0.5, p=NS) at day 3, than patients in group A. The presence of an ESRF or a DDT ≤ 600ms 24 hours after myocardial infarction had a sensitivity of 77%, a specificity of 63%, a positive predictive value of 71%, a negative predictive value of 70% and an accuracy of 71% to predict the absence of LV function recovery at 8 weeks.

**Conclusion:** Assessment of coronary flow velocity pattern at the bedside with TDE allows early identification of patients with poor LV function recovery after acute myocardial infarction.

1052-65

**Differential Diagnosis of Ischemic- and Non-ischemic Cardiomyopathy Using Coronary Flow Velocity Measurements of the Left Anterior Descending Coronary Artery by Transthoracic Doppler Echocardiography**

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**Background:** Ischemic cardiomyopathy (ICM) and non-ICM have similar two-dimensional echocardiographic features, left ventricular dilatation and diffuse wall motion abnormalities.

**Purpose:** The purpose of this study was to test whether transthoracic Doppler echocardiography (TTDE) can detect significant left anterior descending (LAD) coronary artery stenosis and differentiate ICM from non-ICM.

**Methods:** TTDE was performed in 32 consecutive patients (pts) with left ventricular dilatation and diffuse wall motion abnormalities of unknown etiology. Peak and averaged systolic and diastolic flow velocities of the distal LAD flow were recorded and measured. Peak diastolic / systolic velocity ratio (pDSVR) and mean DSVR (mDSVR) were calculated.

POSTER SESSION

**1052 Coronary Artery Disease: Role of Cardiovascular Ultrasound**

Sunday, March 06, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 1:30 p.m.-2:30 p.m.

1052-63

**Circadian Variation Of Coronary Diameter And Coronary Flow In Healthy Volunteer : High Frequency Transthoracic Echocardiographic Study**

Nozomi Wada, Takashi Akasaki, Noriko Okahashi, Yuji Koyama, Nozomi Watanabe, Takahiro Kawamoto, Kiyoshi Yoshida, Kawasaki Medical School, Kurashiki, Japan

**Background:** It has not been investigated whether there is a circadian variation in coronary flow and coronary diameter. Recently, coronary diameter and coronary flow velocity can be measured by transthoracic echocardiography noninvasively in humans (Wada N et.al. J Am Coll Cardiol. 43: 372A [abstract]). We sought to evaluate circadian variation in coronary diameter and coronary flow velocity with high frequency transthoracic echocardiography.



**Results:** (see table) LAD flow measurements could be performed in 28 (88 %) of 32 pts. By coronary angiogram, 8 pts were diagnosed as ICM and 20 as non-ICM. Left ventricular end-diastolic (LVEDV) and end-systolic volumes (LVESV) as well as ejection fraction (LVEF) were similar between ICM and non-ICM. Doppler derived diastolic indices (E/A, deceleration time:DcT) were also similar between the two groups. On the other hand, pDSVR and mDSVR were significantly lower in patients with ICM than non-ICM. A pDSVR <2.0 or mDSVR <2.0 had a sensitivity of 100 % and a specificity of 70 % for detecting the presence of severe LAD stenosis and therefore the diagnosis of ICM.

**Conclusion:** TTDE is a useful non-invasive method to differentiate ICM from non-ICM.

	ICM(n=8)	NonICM(n=20)	p value
Age (yrs)	64 ±15	62±12	NS
Male (%)	63 %	75 %	NS
LVEDV (ml)	153±52	161±61	NS
LVESV (ml)	100±46	101±46	NS
LVEF (%)	36±11	38±10	NS
E/A	1.2±0.5	1.5±0.6	NS
DcT (msec)	173±65	165±79	NS
pDSVR	1.37±0.39	2.48±0.76	0.0006
mDSVR	1.27±0.38	2.40±0.67	0.0002

**1052-66 Acute and Long-term Effect of Cardiac Resynchronization Therapy on Mitral Regurgitation in Patients with Severe Chronic Heart Failure**

Barbara Vidal, Marta Sitges, Alba Marigliano, Lluís Mont, Manel Azqueta, Ernesto Díaz-Infante, David Noguera, Josep Brugada, Carles Paré, Hospital Clínic, Barcelona, Spain

**Background:** Acute reduction of mitral regurgitation (MR) with cardiac resynchronization therapy (CRT) has been shown in patients (p) with left ventricular (LV) dysfunction and LBBB. Few studies have assessed the quantitative impact of CRT on MR over time. We sought to analyze if the acute effect of CRT on MR persists over time using validated quantitative echocardiographic methods.

**Methods:** Sixty-nine p with heart failure, LV ejection fraction (EF) < 35 % and LBBB were studied with color-Doppler echo before, immediately after, and at 6 and 12-month follow-up after CRT. MR was quantified according to the flow convergence method with a hemispherical assumption, determining regurgitant orifice area (ROA) and regurgitant volume (RV). LV volumes and EF (by the biplane Simpson's method) were also determined.

**Results:** There were 31 p (45%) with non-trivial MR (RV > 10 ml/beat); 25 p (36%) had trivial MR (RV < 10 ml/beat) and 13 p (18%) had no MR. Table shows quantitative data of MR and LV volumes without pacing (OFF), immediately after CRT (ON), and at 6 and 12 month follow-up with CRT. Conclusions: 1- CRT acutely reduces MR in patients with LV systolic dysfunction, LBBB and significant MR; this effect persists over a 12 month follow-up period. 2- Although the decrease in MR may be a consequence of LV remodeling, more studies are warranted to analyse the mechanisms leading to this effect .

LVEDV=LV end-diastolic volume; LVESV=LV end-systolic volume; \* p<0,05 vs. OFF

	ROA (mm2)	RV (ml/beat)	LVEDV (ml)	LVESV (ml)	LV EF (%)
OFF	35± 17	48± 21	245± 91	192± 81	21± 6
ON	21± 14*	35± 26*	248± 94	197± 85	22± 6
6 months	24± 18*	32± 21*	252± 82	188± 70	25± 5*
12 months	16± 10*	28± 22*	235± 72	167± 57*	27± 7*

**1052-67 The Impact of Echocardiography and Carotid Ultrasonography in Cardiovascular Risk Stratification**

Francesca Sale, Pietro Sanna, Giuseppe Talanas, Chetti Ros, Laura Sanna, Pier Sergio Saba, Davide Pittalis, Antonello Ganau, University of Sassari, Sassari, Italy

**BACKGROUND.** Both cardiac and carotid ultrasonography (US) are useful in detecting cardiac and vascular preclinical disease in subjects exposed to cardiovascular (CV) risk factors. The aim of the study was to assess the potential additive value of echocardiography and carotid US in CV risk stratification.

**METHODS.** We studied 532 patients (mean age 56±16 years; 42% male) referred to our outpatient clinic for the presence of CV risk factors, in whom both echocardiography and carotid US were available. No patient had history or clinical evidence of CV disease. Diabetes was present in 19% of cases, hypertension in 51%, hypercholesterolemia in 46%. The global CV risk was calculated by the Framingham formula and subjects were divided in four classes of risk (low <=10%, medium 10-20%, high 20-40%, and very high >40%). The individual global risk of subjects with US evidence of left ventricular hypertrophy (LVH), carotid intima-media thickening (IMT) or plaque was multiplied by coefficients of attributable relative risk, derived from literature (coefficient were 2.3 for LVH, 1.57 to 3.86 for IMT, and 1.33 to 2.45 for plaque score). If case of multiple abnormalities, the highest single coefficient was used. For each class of risk, the global number of CV events predicted by the Framingham method was redistributed, so that a proportionally larger number of events was attributed to the group with US evidence of preclinical disease, while the remaining events was used to reassess the risk of the group without cardiac and carotid abnormalities.

**RESULTS.** According to the Framingham stratification, 64% of subjects were at low risk, 23% at medium risk, 11% at high risk and 2% at very high risk. After cardiac and carotid US, the class of risk increased in 40% and decreased in 13% of subjects, while the proportion of patients at high or very high risk increased to 14% and 13%, respectively.

**CONCLUSIONS.** In a sample of patients mostly at low-medium risk, the US investigation of both cardiac and carotid preclinical disease modify the profile of risk in more than half of subjects, doubling the proportion of those at high or very high risk.

**1052-68 Hypochoic Areas on Ultrasound Images of Atheroma Are Not Always Diagnostic of Fatty Plaque**

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**Background:** Atherosclerotic plaques on surface ultrasound images and on intravascular images may have bright areas with shadowing indicative of calcification, bright areas with no shadowing suggestive of fibrous plaque, and hypochoic areas which are often interpreted as fatty plaque. We previously showed that on ultrasound images of myocardial fibrosis obtained with a 600 MHz transducer, fibrous tissue consisting of predominantly thick collagen fibers was hyperechoic, and fibrous tissue composed of thin fibers was normochoic or hypochoic. The current study was designed to test the hypothesis that fibrous tissue in atherosclerotic plaques will be hyperechoic or hypochoic depending on collagen fiber morphology.

**Methods:** Twelve segments of aortic arch containing atherosclerotic plaques obtained from cadavers were suspended in a water bath and imaged with an 8 MHz ultrasound transducer interfaced with a Philips Sonos 5500 ultrasound machine. The gain settings and the distance of the transducer from the specimen were constant for all studies. The images were recorded on videotape. The site of imaging was marked and the specimens were sectioned at that spot, stained with picosirius red and examined with polarized light microscopy (PLM). Thick collagen fibers appear orange or red and thin fibers appear green or yellow on PLM. The ultrasound images were interpreted by an observer blinded to the PLM data and were graded as normochoic, hyperechoic with shadowing, hyperechoic without shadowing, hypochoic, or anechoic.

**Results:** All plaques had heterogeneous echo texture. There were 12 bright areas without shadowing, all of which contained predominantly thick collagen fibers (orange/red). Two areas were anechoic with predominantly thin collagen fibers (green). There were 11 hypochoic areas; 6 of these contained thin fibers and 5 contained no collagen on PLM suggesting fat or thrombus.

**Conclusion:** Fibrous aortic plaques consisting of predominantly thin fibers appear hypochoic or anechoic on ultrasound images and therefore may be indistinguishable from fatty plaques. These findings suggest that a cautious interpretation of ultrasound images of atherosclerotic plaques is warranted.

**1052-69 Early Noninvasive Assessment of Myocardial Viability After Primary Angioplasty for Acute Myocardial Infarction Using Transthoracic Doppler Echocardiography**

Aliocha Scheuble, Marc Faraggi, Eric Brochet, Dominique Himbert, Jean-Michel Juliard, Dominique Le Guludec, Ph. Gabriel Steg, Alec Vahanian, Laurent J. Feldman, Bichat University Hospital, Paris, France

**Background:** High-frequency transthoracic Doppler echocardiography (TDE) allows non-invasive assessment of coronary flow velocity pattern in the left anterior descending coronary artery. We hypothesized that microcirculatory dysfunction assessed by TDE early after primary angioplasty for anterior acute myocardial infarction is associated with poor myocardial viability.

**Methods:** We studied 24 consecutive patients with TIMI 3 flow after primary coronary stenting of the left anterior descending coronary artery for <= 12-hour anterior acute myocardial infarction. Coronary flow velocity pattern and adenosine-induced (140 microgram/kg/min, 5 min iv perfusion) coronary flow velocity reserve (CVR) were measured using a high frequency TDE probe (7MHz, 7V3C Acuson/Siemens) 24 hours and 3 days after primary angioplasty, respectively. At 8 weeks, blinded interpretation of rest <sup>201</sup>Tl single-photon emission computed tomography (TI-SPECT) was performed with a 16-segment grid. Thallium uptake in each segment was scored from 1 (normal) to 4 (no uptake). Absence of myocardial viability was defined by an average thallium score (TS) > 2 in the infarct area.

**Results:** Patients with an early systolic retrograde flow (ESRF) had a larger myocardial infarction than patients without ESRF (TS=2.66 ±0.79 vs 1.32 ±0.38, p<0.0001). The diastolic deceleration time (DDT) negatively correlated with TS (r=-0.75, p<0.0001). CVR also negatively correlated, but to a lower extent, with TS (r=-0.43, p=0.04). The presence of an ESRF or a DDT<= 600ms 24 hours after acute anterior myocardial infarction predicted the absence of myocardial viability with a sensitivity of 91%, a specificity of 69%, a positive predictive value of 71%, a negative predictive value of 90% and an accuracy of 79 %.

**Conclusion:** Evaluation of coronary flow velocity pattern by TDE reliably identifies patients without evidence of myocardial viability, as early as 24 hours after primary angioplasty for anterior acute myocardial infarction.

**1052-70 Prediction of Myocardial Tissue Viability in Patients With TIMI 3 Flow: Analysis Using Transthoracic Color Doppler Echocardiography**

Minako Katayama, Atsushi Yamamoto, Koichi Tamita, Toshikazu Yagi, Shuichiro Kaji, Tomoko Tani, Kazuaki Tanabe, Shigefumi Morioka, Kobe General Hospital, Kobe, Japan, Institute of Biomedical Research and Innovation, Kobe, Japan

**Background:** The Thrombolysis In Myocardial Infarction (TIMI) grading scale after coronary reperfusion yields important prognostic information in patients with acute myocardial infarction. The re-establishment of coronary blood flow to the infarcted region is thought to preserve myocardial viability. However, many patients with angiographic TIMI3 flow have persistent, severe abnormalities of tissue perfusion. Our recent studies have shown that coronary flow velocity pattern (CFVP) with a rapid diastolic deceleration (DDT) implies the advanced microvascular damage. The purpose of this study was to investigate whether CFVP obtained by transthoracic color Doppler echocardiography (TTDCE) can predict myocardial viability in patients who achieved TIMI3 flow.

**Methods:** The study population consisted of 53 consecutive patients with a first anterior acute myocardial infarction successfully treated with percutaneous coronary intervention (angiographically coronary stenosis<=50% with TIMI3 flow). Using TTDCE, we evaluated CFVP in the left anterior descending artery 12 to 48 hours after the intervention. Patients

were divided into two groups based on myocardial viability assessed by thallium-201 single-photon emission computed tomographic (SPECT) imaging 6 months after the infarction. Redistribution patterns or residual maximal myocardial activity >50% are indices of tissue viability.

**Results:** Coronary flow velocity measurement was possible in 48 of 53 patients (91%) by TTCDE and 44 patients underwent thallium-201 SPECT 6 months after the infarction; 33 patients with viable myocardium and 11 patients with nonviable myocardium. Coronary flow velocity variables showed significantly longer DDT (886±269ms versus 442±336ms; p<0.0005) in viable myocardium group compared with nonviable myocardial group. On the basis of ROC curve analysis, optimal cut off values of 600ms for DDT was chosen to predict viable myocardium (sensitivity=0.94, specificity=0.73).

**Conclusion:** Noninvasive assessment of CFVP is useful to predict myocardial viability in patients with acute myocardial infarction. Patients with a DDT≤600ms show poor myocardial viability even they have achieved TIMI3 flow.

to have more overall ventricular dyssynchrony at baseline compared to nonresponders (DI<sub>overall</sub> = 22±5% vs. 14±5%; p = 0.06), and had significantly more ventricular dyssynchrony when the apical segments were excluded from the analysis (DI<sub>BasalMid</sub> = 21±4% vs. 12±1%, p = 0.004). No patient with a baseline DI<sub>BasalMid</sub> < 15 was identified as a responder to CRT. In addition, the acute improvement in overall ventricular dyssynchrony was greater in responders (DI<sub>overall</sub> = 21±5% to 12±4%; p = 0.02) compared to nonresponders (DI<sub>overall</sub> = 14±5% to 16±11%; p = NS).

**Conclusions.** Baseline ventricular dyssynchrony and the acute improvement in ventricular dyssynchrony with CRT as measured by RT3DE can be used to identify long-term responders to CRT. Dyssynchrony of the basal and mid segments of the LV appears to be a better predictor of the response to CRT than overall LV dyssynchrony. Larger studies are needed to confirm these findings.

POSTER SESSION

1053 3-D Echo Assessment of the Ventricles

Sunday, March 06, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 1:30 p.m.-2:30 p.m.

1053-71 Application of Colour Coded Tissue Doppler Imaging and Real Time 3D Echocardiography in the quantification of Mechanical Intra-ventricular Dyssynchrony: a correlation study

Emmanouil Liodakis, Osama Al Sharef, David Dawson, Petros Nihoyannopoulos, National Heart Lung Institute, Imperial College University of London London, London, United Kingdom

**Background:** Mechanical asynchrony (MA) is a major observation in patients with heart failure. Colour coded tissue doppler imaging (TDI) has been used to quantify MA by measuring the standard deviation of the time from Q wave to peak systolic velocity for 12 segments (T<sub>s</sub>-SD). Real time 3D Echocardiography (RT3DE) is a novel technique which provides qualitative and quantitative assessment of MA by measuring the Dyssynchrony Index (DI), which is defined as the standard deviation of the time for the 16 segments to reach their minimum volumes. In this study we sought to determine the correlation between these two methods.

**Methods:** 10 patients (61±10 years) were assessed using TDI and RT3DE. T<sub>s</sub>-SD was measured offline using TDI (Qlab). RT3DE images were acquired using Sonos 7500 and analyzed offline with Tomtec software to derive ejection fraction (EF) and DI (fig).

**Results:** A significant negative correlation was found between EF and both T<sub>s</sub>-SD and DI (r=-0.6 p<0.03, r=-0.7 p<0.01 respectively). A strong positive correlation was also documented between DI and T<sub>s</sub>-SD (r=0.6 p<0.02, fig). There was significant interobserver agreement both in T<sub>s</sub>-SD and DI (r=0.7 p<0.01, r=0.9 p<0.01 respectively). The correlation between measurements was superior for RT3DE compared with TDI (Z=-1.22)

**Conclusion:** MA can be efficiently and accurately assessed using both TDI and RT3DE techniques. However RT3DE provides a more comprehensive quantification by including 16 segments with lower interobserver variability compared to TDI.

1053-73 Serial Follow-up of Left Ventricular Parameters Using Real-time 3D Echo is Comparable to Magnetic Resonance Imaging and Superior to 2D Echo

Carly Jenkins, Lizelle Hanekom, Jonathan Chan, Thomas H. Marwick, University of Queensland, Brisbane, Australia

**Background:** The use of echo for serial follow-up could guide management decisions but has been difficult because of test-retest variation with 2D echo (2DE). Real-time 3D echo (RT3D) is now feasible as a standard clinical tool, and has superior accuracy to 2DE in cross-sectional studies. We sought to assess its reproducibility for serial follow-up of LV measurements in patients undergoing follow-up MRI.

**Methods:** Patients selected for serial follow-up for evaluation of LV parameters (n=17, 14 men, age 63±11) were studied with 2DE, RT3D and MRI. All images were obtained during breath-hold and measurements were made off-line. MRI images were taken within 14 days of the echos and the average interval between the two MRI's was 329±65 days, 3D echo was 347±68 and 2D echo was 341±66.

**Results:** MRI showed EDV to fall from 183±46 to 176±62, ESV to fall from 104±50 to 91±57 and EF to increase from 44±13 to 51±12 over 1 year follow-up. 3D echo measurements of EDV and EF had a closer correlation to MRI than 2D echo (see Table), and analysis of F values showed 3DE to demonstrate less variation than 2DE. The correspondence between 2DE and 3DE and MRI measurements of change in volumes and EF between visits is illustrated in Table 1.

**Conclusions:** There were no significant differences between MRI and 3DE measurement of change of volumes and EF. In contrast, 2DE overestimated change in EDV, and demonstrated greater variability.

Table 1

	ΔEDV (mls)	R (echo vs MRI)	F (echo vs MRI)	ΔESV (mls)	R (echo vs MRI)	F (echo vs MRI)	ΔEF (%)	R (echo vs MRI)	F (echo vs MRI)
MRI	-7±39			-13±17			6±7.0		
2D Echo	-33±25	P=0.24	P=0.04	-17±20	P=0.25	P=0.45	-3±14	P=0.01	P<0.01
3D Echo	-9±52	P=0.74	P=0.12	-17±24	P=0.59	P=0.26	9±8.0	P=0.57	P=0.25

1053-74 Does Qualitative and Quantitative Analysis of Contrast Enhanced Real-time 3D Echo provide Incremental Information in Stress Echocardiography?

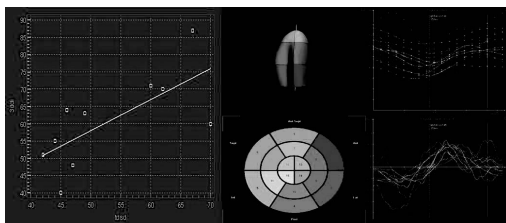
Stamatis Kapetanakis, Penelope Giannakopoulou, George Amin, Mark John Monaghan, King's College Hospital, London, United Kingdom

**Background:** Real-Time 3D echocardiography (RT3DE) provides swift acquisitions independently of axis of acquisition, which may be of value in stress echo. Moreover, global and regional volumetric quantification of RT3DE during pharmacological stress may provide incremental diagnostic information.

**Methods:** 22 patients underwent simultaneous contrast enhanced 2D and RT3D echo at baseline and peak dobutamine stress and the wall motion score index (WMSI) was calculated by both modalities. Global and regional volumetric quantification was performed by RT3DE at both stages. A systolic dyssynchrony index (SDI) was based on dispersion of times to minimum volume for the 16 segments. Time-volume curves were derived for each major arterial territory by creating 3 subvolumes.

**Results:** There was excellent correlation between WMSI by 2D and RT3D echo at baseline (R = 0.96, p < 0.0001) and peak stress (R= 0.92, p < 0.0001). The SDI was similar in patients with and without evidence of IHD at baseline (6.9±4.1 vs. 5.2±2%, p = 0.25). At peak stress, patients with IHD had higher SDI (12.2±6 vs. 4.6±2.5%, p = 0.05). Regional volumetric analysis identified the correct ischaemic territory in 73.8%. A regional EF for the LAD territory identified 100% of abnormal echoes at peak stress.

**Conclusions:** Qualitative analysis of RT3DE shows excellent correlation with established methods. Additionally, volumetric analysis provides quantification of regional function and segmental coordination, which may be of value in stress echo.



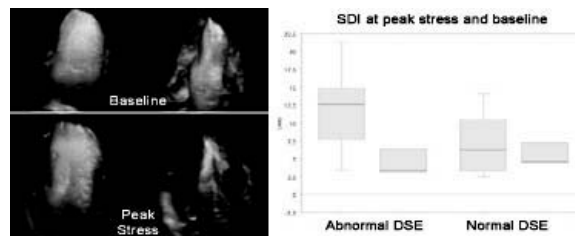
1053-72 Real-Time Three-Dimensional Echocardiographic Index of Ventricular Dyssynchrony Identifies Long-Term Responders to Cardiac Resynchronization Therapy

Thomas E. Hong, Lissa Sugeng, Lynn Weinert, Victor Mor-Avi, Aseem D. Desai, Martin C. Burke, Roberto M. Lang, Bradley P. Knight, University of Chicago, Chicago, IL

Real-time three-dimensional echocardiography (RT3DE) can quantify left ventricular dyssynchrony and evaluate the effects of cardiac resynchronization therapy (CRT). Our goal was to determine whether the magnitude of baseline LV dyssynchrony or the acute change in synchrony in response to CRT predicts long-term benefit from CRT.

**Methods.** We studied 9 pts (6M, 3F; 66±14 yrs) with refractory heart failure (4 ischemic; 5 non-ischemic) and an IVCD (QRS duration = 186±25ms) who were treated with CRT. Patients underwent RT3DE imaging (Philips 7500, X4 probe) with and without CRT 1.4±1.4 months after CRT device implantation. Imaging was repeated 6.2±2.4 months after the initial study. Data were analyzed (TomTec) to obtain LVEF and regional volume over time curves for 16 LV segments (6 basal, 6 mid, and 4 apical). The time from the onset to end of ejection relative to the cardiac cycle length was calculated for each segment, and an index of dyssynchrony (DI) was defined as the standard deviation of the mean ejection time of all segments. Responders to CRT were defined as patients with an absolute improvement in LVEF of at least 5% after 6 months of CRT.

**Results.** 4/9 patients were identified as responders to CRT. Baseline LVEF and LV dimensions did not identify responders to CRT. However, responders to CRT tended



**1053-75 Comprehensive Analysis of Shape-Based Regional Myocardial Strain From 3-D Echocardiography**

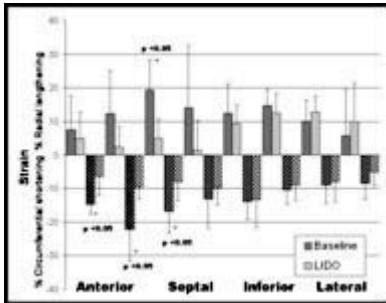
Gaby Weissman, Donna R. Dione, Xenophon Papademetris, Donald P. Dione, David Meoli, James S. Duncan, Albert J. Sinusas, Yale University, New Haven, CT

**Background:** Reliable quantitative approaches for analysis of regional myocardial function from echocardiographic (ECHO) images are still needed. We evaluated a comprehensive shape-based approach for the quantification of regional myocardial strain from 3-D ECHO images.

**Methods:** 3-D ECHO images were acquired in open-chest dogs (n=5) both before and after the creation of regional myocardial dysfunction by intracoronary infusion of lidocaine (LIDO, 8mg/min) into the proximal LAD. Endocardial and epicardial surfaces were defined using a semiautomated algorithm. The shape of the surfaces was used to track the 3-D trajectories of myocardial regions over the cardiac cycle. Shape-based displacements were integrated with a continuous biomechanics model to estimate transmural cardiac-specific strains (Radial-RS; Circumferential-CS; Longitudinal-LS) for 32 myocardial regions.

**Results:** At baseline, RS was fairly uniform across all myocardial segments. However, there was a slight increase in CS and LS in anterior segments relative to the lateral wall. LIDO infusion in the LAD led to a significant decrease in RS in only the septal-anterior segment (p <0.05), while there was a significant (p<0.05) decline in CS in all anterior wall segments. Analysis of CS provided a better index of the extent of regional dysfunction than RS. (see figure)

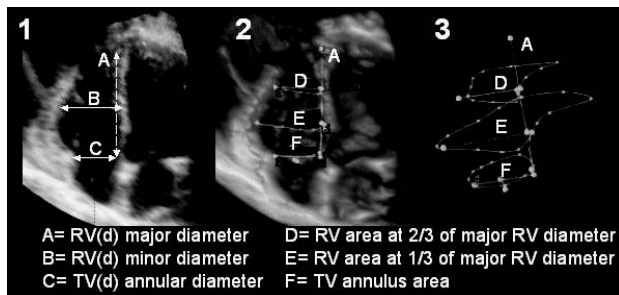
**Conclusion:** Shaped-based analysis of 3-D ECHO provides a novel and comprehensive quantitative approach for assessment of regional myocardial cardiac-specific strain.



**1053-76 Right Ventricular Remodeling in Chronic Pressure Overload: Observations Using Real-Time 3D Echocardiography**

Lissa Sugeng, Nagendra Chouhan, Pankaj Gupta, Lynn Weinert, Patrick D. Coon, H. Joachim Nesser, Roberto M. Lang, Ravi Kasliwal, University of Chicago, Chicago, IL, Escorts Heart Institute, New Delhi, India

The complex shape of the right ventricle (RV) restricts the 2D echocardiographic (2DE) analysis. Real-time 3D echocardiography (RT3DE) is independent of geometric assumptions allowing accurate RV volume measurements. We used RT3DE to study the adaptation of the RV to chronic pressure overload. **Methods.** 20 pts were studied: 10 with moderate to severe pulmonary hypertension (PHTN; PA pressure: 67±30 mmHg) and 10 normal subjects (25±8mmHg). 2DE and ECG gated, wide-angled RT3DE datasets of the RV were acquired from apical windows (Philips 7500, X4 probe) and analyzed off-line (Echo-View, TomTec). From 2DE, diastolic RV major, minor and tricuspid valve (TV) annular dimensions were measured (fig 1). From RT3DE, diastolic RV areas were measured at the TV annulus, at 1/3 and 2/3s of the RV major diameter (figs 2,3). RV volumes were measured at end-systole and end-diastole (RVves, RVved) using disc summation. **Results.** RT3DE analysis of the RV was feasible in all pts. Compared to normals, pts with PHTN had larger RV area at 1/3 (22±18 vs. 14±7cm², p<0.05) and 2/3 (11±10 vs 7.6±6 cm², p<0.05) of the RV major diameter, resulting in greater RVves (38±46 vs18±16 ml/m², p<0.05). and RVved (63±62 vs39±30 ml/m², p<0.05). No intergroup differences were noted in TV annular areas or 2DE data. **Conclusion.** In response to chronic pressure overload, the RV remodels at the apical and mid-ventricular levels while preserving TV annular geometry. RT3DE allows complete assessment of RV geometry and provides new insight into its physiology.



**1053-77 The Efficacy of Real Time 3-Dimensional Echocardiography for Right Ventricular biopsy**

Monica Aggarwal, Cinthia Drachenberg, Layna Douglass, Christopher deFilippi, University of Maryland, Baltimore, MD

**Background:** Repetitive right ventricular (RV) biopsies can result in decreased sample quality by inducing fibrosis with over sampling specific locations. Three-dimensional echocardiography (3D) has been shown to precisely locate the bioptome within the RV compared to fluoroscopy (FI). We sought to determine if a real time 3D (RT3D) guided approach results in differences in biopsy quality compared to FI.

**Methods:** Thirty RV biopsy procedures were performed equally with RT3D or FI in 14 transplant patients. RT3D was performed with a Philips 7500 from the apical 4-chamber position. FI was performed with biplane images. With both RT3D and FI, attempts were made to vary position with each sample to avoid repetitive samples at a fibrotic site. Fibrosis was graded by a pathologist with >50% considered uninterpretable.

**Results:** RT3D provided excellent visualization of the distal end of the bioptome within the right atrium and RV allowing rapid placement on the RV septum (figure). A mean of 4.3 ± 1.0 biopsies were collected per procedure. Of 60 samples obtained by FI, 13 (22%) contained fibrosis and 2 of 14 procedures had >75% uninterpretable samples. Of 68 samples obtained by RT3D, 10 (15%) contained fibrosis and no samples were uninterpretable. Differences in sample quality were not significant between techniques.

**Conclusions:** RT3D echocardiography is a new method to facilitate rapid placement and accurate localization of the bioptome in transplant patients providing comparable quality RV biopsies to biplane FI.



**1053-78 Three-Dimensional Echocardiography in Arrhythmogenic Right Ventricular Dysplasia**

Kalpna R. Prakasa, Chandra Bomma, Darshan Dalal, Harikrishna Tandri, Jianwen Wang, Crystal Tichnell, Cindy James, Mary Corretti, David Bluemki, Hugh Calkins, Theodore Abraham, Johns Hopkins University, Baltimore, MD

**Background:** Arrhythmogenic right ventricular dysplasia (ARVD) is characterized by progressive complex right ventricular (RV) remodeling and dysfunction. We evaluated whether transthoracic, real-time, three-dimensional echocardiography (3DE) can adequately assess RV morphology and function in ARVD. 3DE was compared to cardiac magnetic resonance imaging (CMR), the current gold standard.

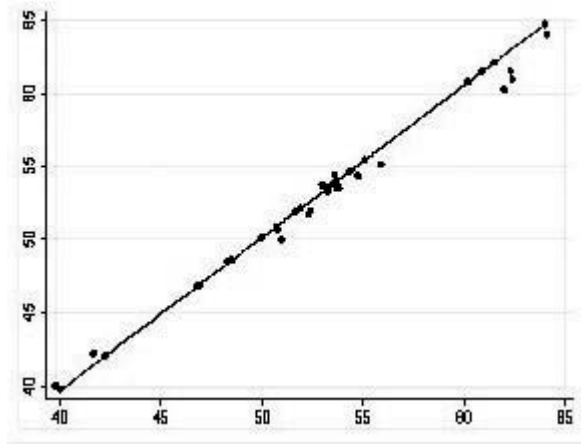
**Methods:** We prospectively performed 3DE and CMR in 20 consecutive patients (5 ARVD, 10 first degree relatives with no ARVD, 5 RV outflow tract tachycardia with no ARVD). ARVD was diagnosed using Task Force criteria. 3DE (Tom Tec software) and CMR (MASS software) data were analyzed off-line by two blinded, independent observers.

**Results:** Mean age of the study group was 34±12 years and 11 were men. There was a close correlation between 3DE and CMR for RV end systolic volume (r=0.58, p=0.01), RV end diastolic volume (r=0.67, p=0.002) and RV ejection fraction (r=0.99, p=0.001). 3DE systematically underestimated RV end systolic (-6.9±8.1 ml, p=0.001) and end diastolic volumes (-14.7±14.9 ml, p=0.0003). Intra (r=0.95) and inter-observer (r=0.66) correlation was good.

**Conclusions:** 3DE measurements of RV volumes and ejection fraction closely correlate with CMR. High intra and inter-observer correlation suggest that 3DE may be useful in follow-up of ARVD patients.

The following graph shows the correlation between 3DE and CMR for RV ejection fraction.

## Correlation Between CMR and 3DE RV Ejection Fraction



## POSTER SESSION

## 1054 Techniques in Computed Tomography Coronary Angiography

Sunday, March 06, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 1:30 p.m.-2:30 p.m.

1054-79 Diagnostic Accuracy of 16-slice Multidetector Spiral Computed Tomography for Detection and Characterization of Congenital Anomalies of the Coronary Arteries

Maros Ferencik, Ricardo C. Cury, Stephan Achenbach, Udo Hoffmann, Thomas J. Brady, Richard R. Libersohn, Suhny Abbata, Massachusetts General Hospital and Harvard Medical School, Boston, MA, University of Erlangen, Erlangen, Germany

**Background:** Contrast-enhanced multidetector spiral computed tomography (MDCT) permits reliable imaging of coronary arteries. We investigated the performance of MDCT for detection and characterization of congenital anomalies of the coronary arteries.

**Methods:** 35 subjects (15 with coronary anomalies detected by invasive angiography and 20 with angiographically proven normal coronary anatomy recruited for other scientific studies) were scanned with 16-slice MDCT (Siemens Sensation 16; 16x0.75mm collimation, rotation 420ms, 120kV, 550mAs, 80mL of iodixanol-320 at 4mL/s). Axial images were reconstructed (thickness 1.0mm, 0.5mm increment, ECG-gated reconstruction). Two independent blinded readers evaluated MDCT (multiplanar reformats, max. intensity projections and 3D images) of patients with coronary anomalies randomly mixed among the cases with normal coronary anatomy for the presence, origin, exact course, proximal vessel caliber and compromise of anomalous coronary vessels.

**Results:** Both observers correctly detected all 15 individuals with coronary anomalies (8 men, age 14-75 years) and all 20 subjects with normal coronary anatomy. As compared to invasive angiography, both observers correctly classified the origin and course of all anomalous coronary vessels (LM n=2; LAD n=2; LCX n=4; RCA n=9). The anomalous RCA had an origin from the left sinus of Valsalva in 4 subjects and above the sinotubular junction in 5 subjects. In 7 subjects, the proximal course of the anomalous RCA was between the right ventricular outflow tract (RVOT) and aortic root. In subjects with an anomalous LM, the proximal segment of the artery was located anterior to the pulmonary artery in 1 case and between the RVOT and aortic root in 1 other case. In 2 subjects with an anomalous LAD, the artery was located between the RVOT and aortic root. All 4 anomalous LCX arteries took a course posterior and inferior to the aortic root. Among 10 subjects with the anomalous artery crossing between the RVOT and aortic root, proximal vessel compromise was detected in 5 subjects.

**Conclusion:** MDCT coronary angiography is a reliable and accurate tool for the detection and characterization of congenital anomalies of the coronary arteries.

1054-80 Detectability of in-Stent Restenosis after Left Main or Ostial Coronary Stenting using 16-Slice Computed Tomography.

Eric Maupas, Meyer Elbaz, Valérie Chabbert, Mehdi Bennaceur, Valérie Cancès-Lauwers, Hervé Rousseau, Jacques Puel, Francis Joffre, Didier Carrié, Cardiology B, Rangueil Hospital, Toulouse, France, (2) Radiology, Rangueil Hospital, Toulouse, France

**Background:** Multislice spiral CT with retrospectively ECG gating is a new approach for non invasive coronary artery imaging. We investigated the method's ability to detect in-stent restenosis after coronary percutaneous angioplasty with stent implantation (left main or ostial coronary artery).

**Methods:** From December 2002 to December 2003, we prospectively studied 135 consecutive patients (pts) in sinus rhythm who had undergone left main (61.5 %) or ostial (38.5 %) coronary artery percutaneous transluminal angioplasty with stent implantation. ECG-gated MSCT angiography was performed with a 16-slice MSCT scanner (Sensation 16, Siemens; 0.42-s rotation time, 12° 0.75-mm slice thickness) 24 hours, and six months after angioplasty. The left main or ostial coronary stents were analyzed by MSCT and in-stent restenosis was graded on a four point scale: 1- none; 2- mid-grade (< 50 % in-stent lumen diameter narrowing); 3- high-grade (> or = 50 %); 4- occlusion. The analysis was independently performed by double blinded observers, with the use of a computer-assisted system. Results were compared with conventional quantitative coronary angiography (QCA). 122 of the 135 pts (90.37 %) had received beta-blocker treatment (average heart rate: 72 +/- 5 min<sup>-1</sup>). After intravenous injection of a non ionic contrast medium with high iodine content, the entire heart was scanned within a single breath-hold.

**Results:** The MSCT investigation was completed successfully without any complications in all pts. Of 135 stents, 116 (85.92 %) were determined assessable 6 months after stenting. All pts were controlled by quantitative coronary angiography and MSCT scanner after a six month follow-up. The sensitivity, specificity, positive and negative predictive values to identify high-grade in-stent restenosis (> or = 50 %) were 71 %, 92 %, 74 % and 94 % respectively.

**Conclusion:** The results suggest that the new generation MSCT scanner is an effective non invasive technology for the visualisation of in-stent restenosis of proximal coronary arteries, and may also become the choice procedure to control these cardiovascular high-risk pts.

1054-81 The Extent of Calcification may Lead to Overdiagnosis of Coronary Artery Stenoses in Multidetector Spiral Computed Tomography

Ryoji Ishiki, Mitsunori Iwase, Nobutake Kurebayashi, Daiji Yoshikawa, Atsushi Takamura, Nobuyuki Yasuda, Yasushi Takeichi, Haruo Inagaki, Toyota Memorial Hospital, Toyota, Japan

**Background:** Multidetector spiral CT (MDCT) with retrospective ECG gating is a new approach for non-invasive coronary artery imaging. MDCT coronary angiography (CTA) permits detection of coronary artery stenoses with reasonable accuracy. However, coronary arteries with severe calcifications have been classified as unevaluable in previous studies. Accordingly, we examined the accuracy of CTA to evaluate coronary artery stenotic lesions with calcified plaques.

**Methods:** Fifty-three patients aged 62.5±8.8 years (74% male) with known or suspected coronary artery disease underwent CTA using a 16-slice scanner with 0.5mm collimation. The scans were performed twice, before and after intravenous injection of a non-ionic contrast medium, in every patient. Data sets of precontrast scan were reconstructed and cross sectional images of coronary arteries were created. The cross sectional area, of which CT density was more than 130HU, was automatically calculated. We defined this area as calcified cross sectional area (C-CSA) of coronary plaque. Data sets of contrast scan were reconstructed and curved multiplanar reconstruction images were used to detect lesions with a diameter reduction of 50% or more. Within one month after CTA, conventional coronary angiographies (CAG) were performed.

**Results:** Among 589 non-stenting coronary segments with a diameter >=2mm, 94 segments were classified as mildly calcified lesions (C-CSA<3mm<sup>2</sup>), 70 as severely calcified lesions (C-CSA>=3mm<sup>2</sup>). For all segments, the sensitivity of CTA to detect significant stenoses was 84% and its specificity was 85%. Importantly, 23 of 70 severely calcified segments had no significant stenoses by CAG and 16 of 23 were overestimated by CTA. The specificity for these severely calcified segments was only 30%, although that for non- or mildly calcified lesions was 91% (p<0.001). On the other hand, the sensitivity had no relations with the extent of calcification (91% in non or mild calcified segments, 89% in severely calcified segments).

**Conclusion:** Although CTA is an effective noninvasive technology to detect coronary artery stenoses even in calcified lesions, CTA has a substantial false positive rate in severely calcified lesions.

1054-82 The Invisible Stent - Imaging of a Self-Degradable Magnesium Alloy Stent with Multislice Spiral Computed Tomography

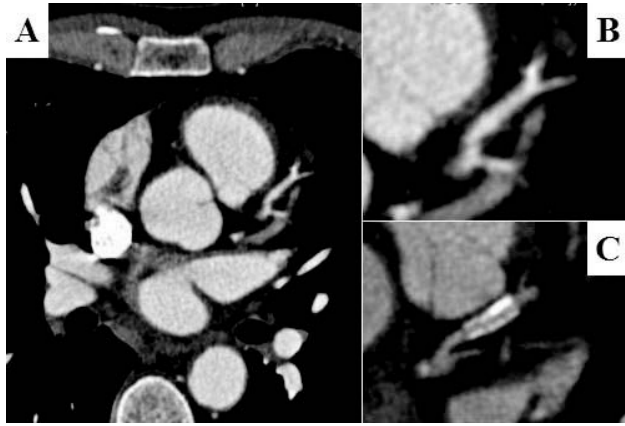
Alexander Y. Lind, Holger Eggebrecht, Jörg Rodermann, Axel Schmermund, Michael Haude, Hilmar Kühl, Raimund Erbel, University of Duisburg-Essen, Essen, Germany

**Background:** Currently noninvasive imaging of coronary arteries by multi-slice spiral computed tomography (MSCT) after stent implantation is limited due to partial volume and hardening effects. Absorbable magnesium alloy metal stents (AMS) may overcome these limitations. We report the results of a noninvasive coronary angiography after implantation of AMS.

**Methods:** In de novo lesions absorbable magnesium alloy stents (BIOTRONIK, Bulach, Switzerland) were implanted in 5 patients in July 2004. The positioning of the stents had to be controlled by intravascular ultrasound (IVUS), because AMS stents consist of more than 90% magnesium and are not imaged by x-ray. After stent placement a contrast enhanced MSCT (Somatom Sensation 16, Siemens, Forchheim, Germany) scan was performed using a 500-ms rotation time and 1,5mm slice thickness during a 35s-breathhold at day 3-5 after implantation.

**Results:** The MSCT demonstrated adequate perfusion throughout the whole arteries without signs of stenosis in the stented area. The stent itself could not be visualized in all 5 patients. (Fig. A and B)

**Conclusion:** The AMS does not interfere with CT imaging. It therefore overcomes the imaging problems of non-absorbable metallic stents (Fig. C) and enables reliable direct visualization of coronary arteries. Thus noninvasive follow-up of these patients by MSCT is feasible for the first time due to adequate differentiation between stent patency, stent-closure, and in-stent-stenosis.



**1054-83 Non-invasive 64-slice Multi-detector Ct Coronary Angiography Of The Entire Coronary Tree In Patients With Stable Angina Pectoris Or An Acute Coronary Syndrome**

Nico R. Mollet, Filippo Cademartiri, Carlos van Mieghem, Giuseppe Runza, Timo Baks, Eugene P. McFadden, Gabriel P. Krestin, Pim J. de Feyter, Erasmus Medical Center, Rotterdam, The Netherlands

**Background:** The new 64-slice Multi-detector Computed Tomography (MDCT) scanner is equipped with higher spatial resolution (0.4 mm in every dimension) and a faster rotation time (330 ms) when compared to previous scanner generations. We compared the diagnostic value of non-invasive 64-slice MDCT coronary angiography to detect significant stenoses ( $\geq 50\%$  lumen diameter reduction) with that of invasive coronary angiography.

**Methods:** We studied 30 patients (18 men, mean age  $57.5 \pm 6.7$  years) with stable angina or an acute coronary syndrome prior to diagnostic conventional angiography. Only patients in sinus rhythm, who had never undergone angioplasty or bypass surgery and were able to breath-hold for 15 seconds, were included. Patients in whom administration of intravenous iodinated contrast material was contraindicated (e.g. known allergy, impaired renal function, or thyroid disorders) were excluded. Patients with pre-scan heart rates  $\geq 70$  beats/minute received oral  $\beta$ -blockade. The heart was scanned after intravenous injection of 100 ml contrast. The MSCT-scans were analysed by 2 observers unaware of the results of invasive angiography and all main coronary arteries and  $\geq 1.5$  mm branches were included for comparison with quantitative coronary angiography.

**Results:** Eighty-seven percent of the included patients received a  $\beta$ -blocker. The mean heart rate was  $57.7 \pm 7.0$  beats/minute and the total scan-time was  $13.1 \pm 1.1$  seconds. Invasive coronary angiography demonstrated no significant stenosis in 20% (6/30), single-vessel disease in 23% (7/30), and multi-vessel disease in 57% (17/30) of patients. There were 47 significantly obstructed vessels. Sensitivity, specificity, positive and negative predictive value for detection of significantly obstructed vessels were 96% (47/49, 95% CI 86-97), 89% (63/71, 95% CI 79-95), 85% (47/55, 95% CI 73-95), and 97% (63/65, 95% CI 89-99) respectively.

**Conclusions:** 64-slice MDCT coronary angiography reliably detects significant coronary stenoses in patients with stable angina pectoris or an acute coronary syndrome.

**1054-84 Effective Dose From Multislice CT Calcium Scoring and Coronary Angiography Compared With Conventional Diagnostic Coronary Angiography**

Duncan R. Coles, Mary Smail, Ian Negus, Peter Wilde, Martin Oberhoff, Karl Karsch, Andreas Baumbach, Bristol Royal Infirmary, Bristol, United Kingdom

**Background:** Developments in technology have made multislice CT (MSCT) a viable modality for cardiac imaging. We compare the effective dose from MSCT coronary angiography with that from conventional diagnostic angiography. The effective dose from calcium scoring scans is also estimated, together with the effect of ECG-controlled tube current modulation for radiation dose reduction. MSCT is a potentially high dose imaging technique and the relative radiation risk should be understood before incorporating it into clinical protocols.

**Methods:** In a prospective study 94 patients with suspected coronary artery disease underwent both Coronary MSCT (Siemens Sensation 16) and conventional coronary angiography (Siemens Axiom Artis FC/BC). CT exposure data was collected for the complete coronary MSCT protocol including calcium scoring (12x1.5mm collimation) without (Group 1: n=52) and with ECG-controlled tube current modulation (Group 2: n=42). MSCT coronary angiography, including test bolus scans, used either 12x0.75mm collimation (Group 1) or 16x0.75mm collimation (Group 2). Effective doses were estimated using the NRPB/ImPACT CT dosimetry calculator. Exposure data was collected for conventional angiography using a single or bi-plane system and effective doses were estimated using PCXMC.

**Results:** The mean effective dose for MSCT coronary angiography including test bolus was  $14.5 \text{ mSv}; \text{s.d. } 2.3$  for 12 detectors (Group 1) and  $15.5 \text{ mSv}; \text{s.d. } 3.3$  for 16 detectors (Group 2), while that for conventional angiography was  $5.7 \text{ mSv}; \text{s.d. } 3.7$  (Group 1) and  $5.3 \text{ mSv}; \text{s.d. } 3.3$  (Group 2). The mean effective dose for calcium scoring was  $4.0 \text{ mSv}; \text{s.d. } 0.3$ ; and with ECG-controlled tube current modulation prospectively applied mean effective dose was reduced by 35% to  $2.6 \text{ mSv}; \text{s.d. } 0.3$ .

**Conclusion:** The mean effective dose for MSCT coronary angiography was significantly higher than that for conventional angiography. Calcium scoring alone is a relatively low dose technique, particularly if ECG-controlled tube current modulation is used. These results suggest that coronary MSCT is a high radiation dose examination. Further evaluation and optimisation of patient dose in the clinical setting is needed.

**1054-85 Evaluation of Stenotic Coronary Artery Stents in 16-Slice Multislice Computed Tomography**

Tsunekazu Kakuta, Osamu Kuboyama, Shigeki Kimura, Taishi Yonetsu, Tomoyuki Umamoto, Hideomi Fujiwara, Mitsuaki Isobe, Tsuchiura Kyodo General Hospital, Tsuchiura, Japan, Tokyo Medical & Dental University, Tokyo, Japan

**Background:** The aim of this study was to evaluate the ability to assess the coronary in-stent lumen in the presence of significant stenosis in multislice CT (MSCT)

**Methods:** Thirty-nine coronary artery stents in 32 patients with angiographically significant stenosis were examined with both 16-slice MSCT and intracoronary ultrasound (ICUS). MIP, MPR, and cross-sectional images were assessed for MSCT image analysis with the use of a medium edge enhancement kernel B41f. Images were analyzed regarding lumen visibility, in-stent CT density, and quantification of minimum in-stent lumen area (MLA), plaque area (PA), and stent area (SA). Data at the most stenotic cross-sections were used for the analysis. SA, MLA, and PA were obtained by visual assessment in the cross-sectional images of MSCT using digital caliper, and compared with ICUS findings. MSCT quantification of SA, MLA, and PA was evaluated by the use of linear regression analysis and the Bland-Altman analysis with ICUS as a reference standard.

**Results:** Five stents were unevaluable due to severe calcification and/or motion artifacts. Mean angiographic % stenosis in 34 evaluable stents was  $67.2\%$ . Mean artificial lumen narrowings were  $46\%$  in 2.5mm stents,  $32\%$  in 3mm stents,  $27\%$  in 3.5mm stents, and  $22\%$  in 4mm stents, respectively ( $p < 0.01$ ). Lowest in-stent lumen CT density (HU) was  $155 \pm 71$ , whereas mean patent in-stent attenuation value (HU) and mean CT density at the reference native segment were  $382 \pm 66$ , and  $329 \pm 53$ , respectively. In thin strut stents, significantly less artificial lumen narrowing and lower in-stent lumen CT density were observed (Multilink Plus<sup>TM</sup>:  $23 \pm 8\%$ ,  $128 \pm 69 \text{ HU}$ ; Multilink Tristar<sup>TM</sup>:  $34 \pm 10\%$ ,  $156 \pm 73 \text{ HU}$ ,  $p < 0.05$ ). SA in MSCT correlated closely to ICUS findings ( $r = 0.94$ ,  $p < 0.001$ ), although systematic underestimation was observed in MSCT. Both MLA and PA in MSCT also significantly correlated to ICUS findings ( $r = 0.78$ ,  $r = 0.92$ , respectively).

**Conclusion:** MSCT evaluation of stenotic coronary stents is feasible and correct when using ICUS as a standard of reference. These data may provide the information of applying MSCT for assessing in-stent lumen stenosis and justify the efforts to develop the stents with regard to artifacts.

**1054-86 Comparison of Multislice Computed Tomography with Conventional Coronary Angiography for the Detection of In-stent Restenosis in the Left Main Coronary Artery**

Carlos Van Mieghem, Erasmus Medical Center, Rotterdam, The Netherlands

**Background:** Multislice computed tomography (MSCT) is a promising technique for non-invasive evaluation of the coronary arteries. We evaluated the diagnostic performance of MSCT to non-invasively detect in-stent restenosis after stenting of the left main coronary artery.

**Methods:** At our institution all patients who underwent stenting of the left main coronary artery (LMCA) are systematically being evaluated with MSCT in addition to a conventional coronary angiogram from March 2004 on. So far we performed MSCT coronary angiography in 41 patients (34 men,  $62 \pm 10$  years) scheduled for conventional coronary angiography 6 months after stenting of the LMCA. All scans were performed using a 16- or 64-slice CT scanner equipped with a high X-ray tube rotation time (375 ms and 330 ms, respectively). Only patients with a regular heart rhythm, able to breath hold for at least 20 seconds, and without contraindications to administer iodinated contrast material (e.g. known allergy, impaired renal function, thyroid disorders) were included. A beta-blocker was administered in case the patient's heart rate was above 65 beats per minute. The angiographic and MSCT analyses were performed independently from each other by one, respectively two observers. In-stent restenosis was defined angiographically as  $\geq 50\%$  diameter stenosis at follow-up. The stent(s) in the LMCA were analyzed by MSCT using following criteria: 0-normal lumen; 1-restenosis; 2-occlusion.

**Results:** All scans were performed within 1 week of the conventional coronary angiogram. Mean heart rate during the scan was  $56 \pm 6$  beats/minute. Total scan time was 18.2 (16-slice) and 13.1 seconds (64-slice). Image quality of MSCT-scans was sufficient for analysis in 38 of the 41 (93%) patients. The sensitivity, specificity, positive and negative predictive value of MSCT to identify in-stent restenosis was 100%, 77%, 27% and 100% respectively.

**Conclusions:** Current MSCT technology, in combination with optimal heart rate control, allows to reliably exclude in-stent restenosis within the left main coronary artery. In this particular group of patients, an initial non-invasive evaluation of the coronary tree thus seems possible.

## POSTER SESSION

### 1055 Positron Emission Tomography and Novel Single-Photon Emission Computed Tomography Approaches

Sunday, March 06, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 1:30 p.m.-2:30 p.m.

#### 1055-87 Impact of Biventricular Pacing in Heart Failure on Myocardial Blood Flow at Exercise

Pascal Koepfli, Patrick T. Siegrist, Corinna Brunnhorst, Christoph Scharf, Michael Klainig, Mehdi Namdar, Christoph A. Wyss, Philipp A. Kaufmann, University Hospital, Zurich, Switzerland

**Background:** Biventricular pacing (bivPM) improves left ventricular (LV) performance by electromechanical resynchronization. However, it remains unclear whether the optimized LV function is due to increased myocardial contractility, requiring an increase in oxygen consumption. This could be potentially hazardous in patients who cannot meet the increased oxygen demand due to reduced myocardial perfusion reserve.

**Aim:** To assess the impact of optimal biventricular pacing on LV myocardial blood flow (MBF) pattern.

**Methods:** MBF was assessed by positron emission tomography (PET) and 15O-labeled water in 4 patients (age 68±4 years) with chronic severe congestive heart failure at rest, during standard adenosine stress and immediately after bicycle exercise (45±10 watts) in the PET scanner. All MBF measurements were performed with bivPM off and repeated with bivPM on (identical exercise workload). Pacing was programmed to atrial sensing followed by ventricular pacing in order to allow a physiological heart rate response during exercise. Coronary flow reserve was calculated as hyperemic (adenosine and bicycle stress) / resting MBF.

**Results:** Global MBF (ml/g/min) was not affected by bivPM: 0.88±0.09 (bivPM off) vs. 0.98±0.12 (bivPM on) at rest, 1.45±0.43 (bivPM off) vs. 1.47±0.49 (bivPM on) during adenosine and 1.23±0.13 (bivPM off) vs. 1.23±0.10 (bivPM on) after bicycle stress (all p-values = ns). Also regional MBF, coronary flow reserve and rate pressure product did not differ with PM off and on.

**Conclusion:** Although biventricular pacing improves LV performance it is not associated with an increase in MBF neither at rest nor at pharmacological or physical exercise stress. Our findings suggest, that biventricular pacing improves LV function mainly by resynchronization rather than by increasing myocardial contractility, supporting its use in patients with impaired flow reserve.

#### 1055-88 Impaired Microvascular Function Within Noninfarct-Related Area May Relate to Left Ventricular Remodeling After Myocardial Infarction

Tohru Geshi, Jong-Dae Lee, Akira Nakano, Hiroyasu Uzuji, Reiko Nakaya, Kiyohiro Toyoda, Naoki Amaya, Haruhisa Shirasaki, Toshihiro Mizuguchi, Takanori Ueda, Hidehiko Okazawa, Yoshiharu Yonekura, University of Fukui, Fukui, Japan

**Background/Aim:** Several studies have shown that impaired myocardial flow reserve (MFR) within non-infarct-related area (NIRA) early after the onset of myocardial infarction (MI) persists over 6 months period. However, the relationship between the extent of microvascular impairment within NIRA and left ventricular (LV) remodeling is still unknown. The aim of this study was to elucidate whether the impaired microvascular function within NIRA relates to LV remodeling after MI.

**Methods:** We prospectively studied 15 patients (9 men, mean 69 yrs) with first MI who underwent successful coronary angioplasty within 12 hours after the onset. All patients had single vessel disease and showed no restenosis in infarct-related artery during observation period. The MFR within NIRA and infarct-related area (IRA) was assessed using <sup>13</sup>N ammonia positron emission tomography at 2 weeks after the onset. Peak creatinine phosphokinase (CPK) and defect score in <sup>99m</sup>Tc-tetrofosmin myocardial perfusion imaging (TF) were used for defining as the severity of myocardial infarction. LV end-diastolic volume index (LVEDVI) and the change in LVEDVI ( $\Delta$ LVEDVI) were measured using left ventriculography at the onset and 1 month later.

**Results:** The MFR within NIRA was 2.02 ± 1.67, which was lower than normal values as previously reported. When patients were re-classified into group S (severely impaired, MFR < 2.0) and group M (mildly impaired, MFR ≥ 2.0), the peak CPK (8971 ± 5158 IU/l vs. 2575 ± 2193 IU/l, p = 0.014), the defect score in TF (19.0 ± 2.6 vs. 8.8 ± 7.3, p = 0.047), LVEDVI at 1 month (150.1 ± 9.0 ml/m<sup>2</sup> vs. 80.6 ± 19.6 ml/m<sup>2</sup>, p = 0.003), and  $\Delta$ LVEDVI (30.5 ± 2.4 ml/m<sup>2</sup> vs. -10.7 ± 8.9 ml/m<sup>2</sup>, p = 0.0004) were significantly greater in group S than group M. The MFR within NIRA was inversely correlated with the LVEDVI at 1 month (r = -0.734, p = 0.01) as the MFR within IRA (r = -0.898, p = 0.00017) was.

**Conclusion:** Data indicated that microvascular impairment within NIRA was related to the severity of myocardial infarction, and might contribute to LV remodeling after MI.

#### 1055-89 Calcium Antagonists did not improve BMIPP Cardiac Scintigraphy in Patients With Pure Coronary Spastic Angina

Shozo Sueda, Yousuke Izoe, Hiroshi Fukuda, Saiseikai Saijo Hospital, Saijo, Japan

**Background:** Medical therapy including a calcium antagonist (Ca) has been effective to reduce angina attacks in pts with variant angina. However, there are no reports regarding the effectiveness of Ca on myocardial BMIPP images in pts with pure coronary spastic angina (CSA). This study sought to examine the correlation between BMIPP scintigraphy and the effectiveness of Ca administration in pts with pure CSA.

**Methods:** This study included 35 consecutive pts (28 men, mean age of 66±10 years) with angiographically confirmed CSA and no fixed stenosis. Long acting Ca was administered in all 35 pts. Isosorbide dinitrate / nicorandil / another Ca / beta-blocker was administered when chest pain was not controlled. Using an iodinated fatty acid analogue, 15-(p-[iodine-123] iodophenyl)-3-(R,S) methylpentadecanoic acid (BMIPP), cardiac scintigraphies with intravenous adenosine triphosphate infusion were performed before cardiac catheterization 12 mo and 24 mo after medical therapy. According to the control states, these 35 pts were classified into 3 groups; good (disappearance of angina attacks, 11 pts, 60±11 years), moderate (angina attacks < 4/mo, 12 pts, 67±10 years), and poor control (angina attacks ≥ 4/mo, 12 pts, 71±6 years).

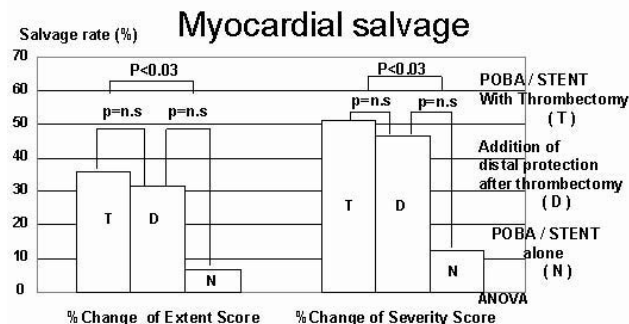
**Results:** Reduced BMIPP uptake was observed in 24 (69%) of 35 pts before the treatment. Reduced BMIPP uptake was also found in 16 pts (46%) after 12 mo, and in 17 pts (49%) after 24 mo. Normal BMIPP uptake after 24 mo therapy was observed in about half of pts among the 3 groups. There was no difference regarding the value of washout rate among the 3 groups. The defect scores of BMIPP(DS) in the good and moderate control groups were not different during the two years medical therapy, while DS in the poor group was significantly decreased in 12 mo and 24 mo (10.3±6.3 (before) vs. 6.8±5.7 (12 mo), 6.4±7.0 (24 mo), p<0.05). The administration of Ca and isosorbide dinitrate/nicorandil and 2 Ca were significantly higher in the poor than in the good control pts.

**Conclusion:** Medical therapy including a long acting Ca did not improve myocardial fatty acid metabolic images in pts with pure CSA. It may be concerned silent ischemia due to coronary vasospasm, irrespective of the disappearance of anginal attacks.

#### 1055-90 Myocardial Salvage in Acute Myocardial Infarction: Thrombectomy Versus Addition of a Distal Embolic Protection Device to Primary Angioplasty

Noriaki Ito, Takakazu Morozumi, Shinsuke Nanto, Masaaki Uematsu, Jun-ichi Kotani, Masaki Awata, Toshinari Onishi, Osamu Iida, Fusako Oshima, Hitoshi Minamiguchi, Seiki Nagata, Kansai Rosai Hospital, Amagasaki, Japan

**Background:** Thrombectomy prior to primary angioplasty as well as distal embolic protection assisted angioplasty has recently been attempted in patients with acute myocardial infarction (AMI). However, whether the combination of distal protection further salvage myocardium at risk remains unclear. **Methods:** We studied 61 consecutive patients with AMI (51 males, age ranged 38-86 years) between April 1999 and August 2003. Twenty-one patients received extensive thrombectomy prior to angioplasty and 9 patients were treated with a balloon type distal protection after thrombectomy, whereas 31 patients received neither thrombectomy nor distal protection. Myocardial salvage was quantified by myocardial perfusion SPECT performed before and two weeks after the procedure. The defect extent score (ES) and the severity score (SS) were analyzed. Myocardial salvage was evaluated by % change in ES: [(preES-postES)/preESx100] and that in SS: [(preSS-postSS)/preSSx100]. **Results:** Patients' demographics; pre-procedural TIMI flow grades; elapsed time from the onset to angioplasty; ES and SS on admission; peak CPK and peak CK-MB; final TIMI flow grades; ES and SS after the procedure were all similar among the groups. Nonetheless, changes in ES and SS indicated the beneficial effect of thrombectomy (Figure). **Conclusion:** Thrombectomy prior to primary angioplasty improved myocardial salvage in AMI. Addition of the distal embolic protection to thrombectomy could not further salvage the myocardium at risk.



#### 1055-91 Myocardial Efficiency Reserve Predicts the Deterioration in Exercise Capacity Over Time in Patients with Heart Failure

Keiichiro Yoshinaga, Heikki Ukkonen, Ian Burwash, Robert deKemp, William Dafeo, Ross A. Davies, Haissam Haddad, Terrence D. Ruddy, Jean N. DaSilva, Rob Beanlands, University of Ottawa Heart Institute, Ottawa, ON, Canada

**Backgrounds:** Myocardial efficiency (ME) and ME reserve (MER) can be estimated non-invasively using C-11 acetate PET measurement of oxidative metabolism and echocardiographic measurement of stroke volume (SV) at rest and during dobutamine infusion. In patients with heart failure (HF), ME has been shown to be a strong predictor of survival. However, the potential utility of ME or MER for predicting the functional capacity of HF patients in follow-up has not been defined. We investigated whether ME and MER could provide prognostic information on the exercise (Ex) capacity of HF patients over time.

**Methods:** 25 patients with HF were prospectively studied [age=66±8 yrs, LVEF=31±8%, ischemic (n=18)]. ME was estimated by the Work-Metabolic Index (WMI = SV index (SVI) x HR x systolic BP / k-mono, where k-mono is the monoexponential fit of the myocardial C-11 acetate PET time-activity curve). MER was derived from the % change of WMI at rest and during dobutamine infusion (10 µg/kg/min). Ex capacity [maximal oxygen uptake (Peak VO<sub>2</sub>)] was measured at baseline and at 6 months follow up in all patients. Worsening Ex capacity was defined as ≥ 10% decrease in peak VO<sub>2</sub>.

**Results:** At the baseline study, dobutamine infusion resulted in an increase in SVI ( $35 \pm 9$  to  $40 \pm 9$  ml/m<sup>2</sup>,  $p < 0.001$ ), k-mono ( $0.047 \pm 0.009$  to  $0.061 \pm 0.013$ /min,  $p < 0.001$ ) and WMI ( $6.1 \pm 1.7 \times 10^4$  to  $7.9 \pm 1.8 \times 10^4$ ,  $p < 0.001$ ). MER was  $32 \pm 26\%$ . From baseline to 6-month follow-up, Ex workload and peakVO<sub>2</sub> decreased from  $4.8 \pm 1.4$  to  $4.3 \pm 1.1$  METS ( $p < 0.03$ ), and  $16.7 \pm 4.8$  to  $15.2 \pm 3.8$  ml/kg/min ( $p = 0.057$ ), respectively. Among rest and dobutamine parameters, only MER correlated with the change in Ex capacity over time ( $r = 0.56$ ,  $p < 0.005$ ). An MER  $\leq 35\%$  predicted a worsening exercise capacity with a sensitivity, specificity, PPV and NPV of 79%, 82%, 85%, and 75%, respectively.

**Conclusions:** Myocardial efficiency reserve correlates with the change in exercise capacity over time in patients with HF. A myocardial efficiency reserve  $\leq 35\%$  predicts functional deterioration with good accuracy. The myocardial efficiency reserve may be a useful clinical prognostic parameter in heart failure patients.

1055-92

**Association Between Lung Heart Ratio and Body Mass Index on stress 99m Tc Sestamibi SPECT Perfusion Imaging**

Hitender Jain, Raymond Russell, Frans J. Th. Wackers, Yale University Hospital, New Haven, CT

Increased lung heart ratio (LHR) on stress 99m Tc sestamibi SPECT perfusion imaging is recognized as a marker of poor outcome. Even though initial studies have shown an association between LHR and body weight, the exact impact of body weight on LHR has not been investigated thoroughly.

**Methods and results:** We retrospectively analyzed data from 2569 patients undergoing 99m Tc sestamibi SPECT perfusion studies. On multiple regression analysis two factors correlated significantly with LHR: stress ejection fraction (EF) and body mass index (BMI) ( $p = 0.04$  and  $0.001$  respectively). When patients were divided in to four groups based on BMI criteria for obesity (Normal =  $< 25$ , overweight =  $25-29.9$ , Obese =  $30-39.9$ , morbid obesity =  $\geq 40$ ), a gradual increase in LHR was seen with statistically significant difference between groups ( $p < 0.0001$ ).

As reported in previous studies a high LHR was found to have a significant association with abnormal EF at stress and rest, quantified size of the stress perfusion defect and degree of defect reversibility based on linear regression analysis. However, on multiple regression analysis a high LHR ( $n = 164$ ) was most strongly associated with BMI ( $p = 0.004$ ) followed by stress perfusion defect score ( $p = 0.014$ ) when compared to other factors such as stress EF, size of rest perfusion defect, age and sex. In patients with high LHR, 89 % had a high BMI, 26.3 % had a low EF and 59.4 % patients had a perfusion defect with exercise.

**Conclusion:** BMI plays an important role in determining LHR with obese patients tending to have significantly higher LHR. This may be due in part to differential attenuation due to differing amounts and distribution of adipose tissue. A high BMI may explain why some patients with no perfusion defects have a high LHR.

1055-93

**Myocardial Perfusion Imaging and Cardiac Troponin T Provide Complementary Information for Identifying Patients with Acute Coronary Syndrome in the Emergency Department**

Taku Sakai, Yasunori Ueda, Yuji Okuyama, Yuzuru Takano, Sei Komatsu, Isamu Mizote, Atsushi Hirayama, Kazuhisa Kodama, Osaka Police Hospital, Osaka, Japan

**Background:** Definite identification of patients with acute coronary syndrome (ACS) among those who admitted to emergency department with possible myocardial ischemia is difficult. Myocardial perfusion imaging with technetium-99m and cardiac troponin T (cTnT) both can identify patients with acute coronary syndrome.

**Objectives:** The purpose of this study was to compare the ability of myocardial perfusion imaging and cTnT assessment to identify patients with ACS, and to evaluate the efficacy to determine early invasive strategy in patients presenting to the emergency department with chest pain.

**Methods:** Patients considered ACS underwent technetium-99m tetrofosmin single photon emission computed tomography (SPECT) and measurements of cTnT on admission. Positive myocardial perfusion imaging was defined as a perfusion defect with associated abnormalities in echocardiographic wall motion. cTnT  $\geq 0.1 \mu\text{g/l}$  was considered abnormal.

**Results:** Among the 190 patients studied, 140 patients were diagnosed as ACS. Of these ACS patients, 113 (59.5%) underwent revascularization therapy. Perfusion imaging, cTnT were positive in 144 (75.8%), 97 (48.7%) patients respectively; of those patients, 123 (64.7%), 85 (44.7%) patients were diagnosed ACS. Among 55 ACS patients with negative cTnT value, 41 (74.5%) patients had positive perfusion imaging, and underwent revascularization in 39 (70.9%) patients. Sensitivity of ACS for perfusion imaging was higher (87.9%) than for cTnT (60.7%), and specificity of ACS was not significantly different between perfusion imaging (58%) and cTnT (60%). Sensitivity and specificity of ACS presenting positive perfusion defects with elevated cTnT were 58.6%, 80%.

**Conclusion:** Compared with cTnT, sensitivity of perfusion imaging for predicting ACS was higher, especially for patients who underwent revascularization. Positive perfusion imaging with elevated cTnT showed higher specificity of ACS than either positive perfusion imaging or elevated cTnT alone. Emergent perfusion imaging and cTnT can demonstrate complementary information for identifying patients with ACS, and useful for deciding early invasive therapy.

1055-94

**The Effect of Verapamil on Restoration of Myocardial Perfusion and Functional Recovery in Patients with Angiographic No-Reflow After Primary Percutaneous Coronary Intervention**

Shigeo Umemura, Seishi Nakamura, Tetsuro Sugiura, Yoshiaki Tsuka, Tetsuya Kitamura, Susumu Yoshida, Masato Baden, Toshiji Iwasaka, Kansai Medical University, Moriguchi, Japan, Kochi Medical School, Kochi, Japan

**Background;** Angiographic Thrombolysis in Myocardial Infarction (TIMI) flow grade  $\leq 2$  after primary percutaneous coronary intervention (PCI), defined as angiographic no-reflow, predicts poor left ventricular functional recovery in patients with acute myocardial infarction (MI).

**Methods;** To investigate the effect of verapamil on restoration of myocardial perfusion and functional recovery in patients with angiographic no-reflow after PCI, technetium-99m (99mTc) tetrofosmin single-photon emission tomographic (SPET) imagings were performed (before, immediately after and 1 month after PCI) in 124 consecutive patients with acute MI. Defect score was calculated as the sum of perfusion defect in 13-segment model (scores of 3, complete defect to 0, normal perfusion). Asynergic score were serially assessed by echocardiography before and 1 month later.

**Results;** Of 124 patients, 35 patients (28%) had angiographic no-reflow and were divided into two groups: 23 patients with verapamil (Group 1) and 12 patients without verapamil (Group 2). Eighty-nine patients had TIMI grade 3 reflow after PCI (Group 3). The change in defect score at 1 month after PCI in Group 1 was significantly larger than that in Group 2 ( $12.8 \pm 5.3$  to  $7.6 \pm 4.8$  vs.  $15.3 \pm 4.7$  to  $12.0 \pm 5.8$ ;  $p = 0.02$ ). Asynergic score improved more at 1 month in Group 1 compared to that in Group 2 ( $3.9 \pm 1.8$  to  $1.3 \pm 1.4$  vs.  $4.5 \pm 2.0$  to  $3.0 \pm 2.5$ ;  $p = 0.03$ ). Moreover, these improvements in Group 1 was identical to that in Group 3 (defect score:  $13.7 \pm 4.5$  to  $6.1 \pm 4.2$ , asynergic score:  $3.1 \pm 1.7$  to  $0.9 \pm 1.4$ ).

**Conclusion;** Thus, intracoronary verapamil restored myocardial perfusion in patients with angiographic no-reflow after PCI and lead to better functional recovery after acute MI.

POSTER SESSION

1081 **Diagnostic and Prognostic Issues in Stress Echocardiography**

Monday, March 07, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 11:00 a.m.-Noon

1081-87

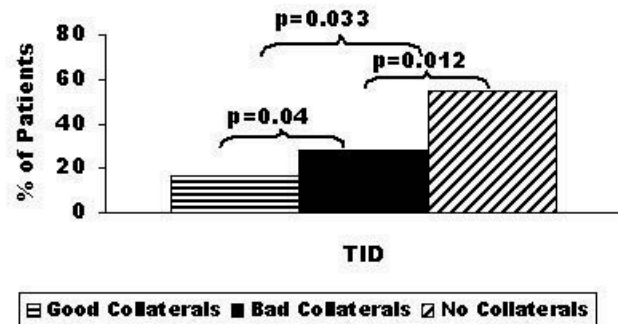
**Impact of Coronary Artery Collaterals on Transient Ischemic Left Ventricular Dilatation on Stress Echocardiography**

Sripal Bangalore, Siu-Sun Yao, Devi Gopinath, Utpal Patel, Ajay Shah, Nilo Ayuyao, Asif Malik, Farooq A. Chaudhry, St Luke's-Roosevelt Hospital Center, New York, NY

**Background:** The role of coronary artery collaterals in transient ischemic left ventricular dilatation (TID) during stress echocardiogram is not well defined.

**Methods:** We evaluated 212 consecutive patients ( $57 \pm 16$  years, 70% male) who had coronary angiography and stress echocardiography within a 3-month period. This cohort of patients were divided into 3-groups based on type of collaterals: group A: no collaterals; group B: collaterals supplied by vessels without flow limiting stenosis (good collaterals); group C: collaterals supplied by vessels with flow limiting stenosis (bad collaterals). In all patients, angiographic jeopardy score (AJS), ejection fraction (EF) and wall motion score index (WMSI) at rest and during stress were evaluated. TID was defined as transient increase in the end systolic dimensions from rest to peak stress.

**Results:** TID was present in 42 (20%) patients. Patients with TID had a lower EF ( $37 \pm 18$  vs.  $47 \pm 18$ ,  $p = 0.004$ ), higher AJS ( $5.1 \pm 4.2$  vs.  $3.4 \pm 3.8$ ,  $p = 0.02$ ), greater number of ischemic segments ( $7.2 \pm 4.2$  vs.  $2.9 \pm 3.2$ ,  $p < 0.0001$ ) and higher peak WMSI ( $2.6 \pm 0.7$  vs.  $1.8 \pm 0.8$ ,  $p < 0.0001$ ). Patients with TID had greater percentage of multivessel disease, greater percentage of group A (no collaterals) and group C collaterals (jeopardized collaterals) than group B collaterals (graph).

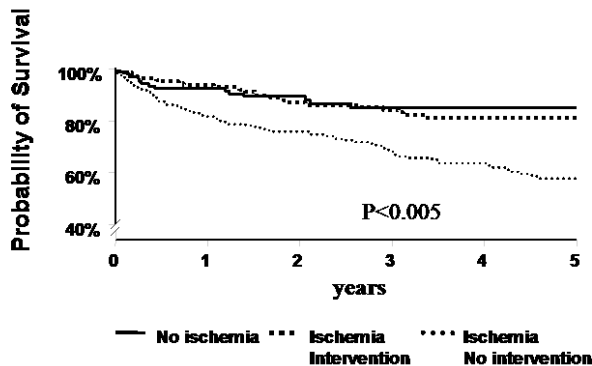


**Conclusion:** TID on stress echo is a marker for extensive and severe CAD and may represent patients with angiographically absent collaterals or those with jeopardized coronary collaterals (bad collaterals).

**1081-88 Incremental Prognostic Significance of Myocardial Ischemia in Patients With Heart Failure**

Abdou Elhendy, Fabiola B. Sozzi, Jeroen J. Bax, Ron T. van Domburg, Arend F. Schinkel, Don Poldermans, Thoraxcenter, Rotterdam, The Netherlands, University of Nebraska Medical Center, Omaha, NE

**Background.** Aim of the study was to assess the impact of ischemia during dobutamine stress echocardiography (DSE) on cardiac mortality in patients (pts) with heart failure (HF). **Methods.** We studied 528 pts (age = 62 ± 11 year, 402 men) with HF and a history of myocardial infarction or coronary artery disease, who underwent DSE. Ischemia was defined as new or worsening wall motion abnormalities or a biphasic response. **Results.** Mean ejection fraction was 35 ± 12%. Ischemia was detected in 407 (77%) pts. During a follow up of 3.2 ± 2.4 years, cardiac death occurred in 150 (28%) pts. Myocardial revascularization was performed within 4 months in 117 (29%) pts with ischemia. The annual cardiac death rate was 4.8% in pts without ischemia, 5.5% in pts with ischemia who underwent revascularization within 4 months and 11.8% in pts with ischemia who were not revascularized (p<0.005) (figure). In a multivariate analysis model, predictors of cardiac death were diabetes (risk ratio [RR] = 2, 95% CI 1.4-2.9), male sex (RR 1.7, CI 1.2-3.1), low dose wall motion score index (RR 1.4, CI 1.2-2.6) and ischemia (RR 1.9, CI 1.3-3.2). Angina was not predictive. In pts with ischemia, revascularization within 4 months of DSE was associated with reduced risk of cardiac death (RR = 0.4, CI 0.3-0.8). **Conclusion.** Myocardial ischemia detected by DSE is associated with increased risk of cardiac death among pts with HF, after adjustment for left ventricular function. Revascularization within 4 months is associated with a better outcome in pts with ischemia.



**1081-89 Application of a Scoring System to Screen Diabetic Patients for Coronary Artery Disease and Cardiovascular Events with Exercise Echocardiography**

Dhruvo Rakshit, Melodie Downey, Stuart Moir, John Prins, Thomas Marwick, University of Queensland, Brisbane, Australia

**Background:** Stress echo (SE) can predict mortality in pts with diabetes mellitus (DM), but its use in screening for coronary artery disease (CAD) is limited by low disease probability in asymptomatic DM. We compared 3 scoring systems to identify a high-risk (HR) group with a greater probability of CAD and cardiac events (CE), to reduce the number of screening studies. **Method:** In 199 DM (57 y, 110 men, DM duration 10 y), we compared i) Framingham risk score (FS), ii) Risk Factor Score (RFS), based on number of risk factors (DM, smoking, LDL>150mg/dl, HDL<35mg/dl, GFR<90mls/min, hypertension, family history) and iii) Diabetic Cardiac Risk Score [DCRS] (Machecourt, Circulation 2003;108:IV-332). HR groups were defined by a FS>1% per yr, a RFS≥3 (DM plus 2 risk factors) or a DCRS>25. All pts had ExE; 23 out of 27 pts with positive ExE had coronary angiography (CA). **Results:** High-risk was identified in 27% with the DCRS, fewer than with RFS (41%, p<0.01) and the Framingham score (66%, p<0.001). Using the DCRS, the majority of pts with CE or CAD were in the HR group, but the FS and RFS were less discriminatory (table). There were 9 CE and no deaths in 189 pts followed over 1.1 yrs. In HR pts, 12% had CE using the DCRS, compared to 6% with the FS and RFS.

	Framingham			Risk Factor Score			Diabetic Cardiac Risk Score		
	High risk (n=131)	Low risk (n=68)	p	High risk (n=81)	Low risk (n=118)	p	High risk (n=54)	Low risk (n=145)	p
CAD by ExE	18	9	0.92	14	13	0.21	16	11	<0.001
CAD by CA	10/14	1/9	0.005	6/11	5/12	0.54	9/13	2/10	0.02
Event	7	2	0.43	5	4	0.39	6	3	0.007
No event	117	63		74	106		46	134	

**Conclusion:** DCRS identified pts with a higher likelihood of positive ExE and CE, and was superior to the FS and RFS. Combining SE with the DCRS optimizes detection of CAD and prediction of future CE in asymptomatic pts, while minimizing the numbers of required SE and minimizing false positive SE.

**1081-90 Brain Natriuretic Peptide Predicts Ischemic Response During Dobutamine Stress Echocardiogram**

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**Background:** Elevated Brain Natriuretic Peptide (BNP) in the setting of acute coronary syndrome has important prognostic information. Patients referred for dobutamine stress echocardiogram (DSE) may have resting ischemia which could mean elevated BNP levels. **Methods:** We measured BNP, pre stress in 142 unselected patients referred for dobutamine stress echocardiogram (DSE). Ischemia was defined as any new reversible wall motion abnormality and/or biphasic response. Echocardiogram readings were blinded to BNP levels. Receiver operating characteristics (ROC) curves were obtained to predict the BNP value with maximum accuracy. BNP was analyzed independently at Biosite Inc. **Results:** Results are as detailed in the Table with the BNP level divided into tertiles. ROC curve showed that at the best possible cut-off level of >50 pg/mL, pre stress BNP level has a sensitivity of 60.9%, specificity of 79.2% and positive likelihood ratio of 2.92 to predict ischemia on DSE. The area under the curve was 0.736 (p<0.001). Multivariate logistic regression analysis showed that pre stress BNP levels was a significant predictor of ischemia on DSE (p =0.006) after controlling for age (p=0.004) and diabetes mellitus (p = 0.001). **Conclusions:** In an unselected cohort, pre stress BNP > 50 pg/mL predicts ischemia on DSE. In patients unable to exercise, an elevated BNP in the absence of heart failure can further risk stratify patients undergoing DSE.

	Tertile 1 (0-7.9 pg/ml) N = 48	Tertile 2 (8.5-50.7 pg/ml) N = 49	Tertile 3 (54.4-1756.7 pg/ml) N = 45	P value
Age	59 ± 12	62 ± 13	69 ± 10	<0.0001
Men	20 (42%)	26 (53%)	19 (42%)	0.45
Hypertension	27 (56%)	37 (75%)	38 (84%)	0.008
Angina	2 (4%)	2 (4%)	3 (7%)	0.90
Diabetes Mellitus	22 (46%)	11 (22%)	26 (58%)	0.002
History of myocardial infarction	6 (12%)	6 (12%)	13 (29%)	0.056
Body Mass Index	32 ± 10	33 ± 11	28 ± 6	0.036
B- blocker use	20 (41%)	19 (39%)	23 (51%)	0.45
ACE- inhibitor use	17 (35%)	11 (22%)	20 (44%)	0.076
Digoxin use	1 (2%)	3 (6%)	2 (4%)	0.61
LV ejection fraction (%)	57 ± 4	57 ± 7	46 ± 17	<0.0001
Ischemia on DSE (%)	17	24	56	0.001
Relative Risk Ratio to predict ischemia	1.0	1.6 (0.6-4.4) p=0.341	4.2 (1.7-10.2) p=0.001	

**1081-91 Prediction of Long-Term Prognosis in Patients With Ischemic Cardiomyopathy Undergone Coronary Revascularization: The Role of Contractile Reserve and Ischemia**

Vittoria Rizzello, Don Poldermans, Elena Biagini, Arend FL Schinkel, Eric Boersma, Eleni C. Vourvouri, Gian Federico Possati, Jos RTC Roelandt, Jeroen J. Bax, The Thorax Center Erasmus MC, Rotterdam, The Netherlands, The Catholic University of The Sacred Heart, Rome, Italy

**Background.** In patients with ischemic cardiomyopathy, the presence of myocardial viability is associated with favourable prognosis after coronary revascularization. Contractile reserve (CR) and ischemia represent different features of myocardial viability. Aim of the present study was to evaluate the relative role of CR and ischemia in the prediction of long-term prognosis after revascularization. **Methods.** Low-high dose dobutamine stress echocardiography (DSE) was performed before coronary revascularization in 128 consecutive patients with ischemic cardiomyopathy (mean left ventricular ejection fraction (LVEF) 31± 8%) and symptoms of heart failure (NYHA class 2.6± 1.1). Improvement of the contractile function during dobutamine infusion in dysfunctional segments defined the presence of CR. Deterioration of contractile function, with and without initial improvement, defined the presence of ischemia. Cardiac death was evaluated during long-term follow-up (up to 5 years). Clinical, angiographic and echocardiographic data were analysed to identify predictors of cardiac death. **Results.** During the 5-year follow-up period, cardiac death occurred in 27 patients. Univariable predictors of cardiac death were the presence of multi-vessel diseases (HR 0.21, P<0.001), baseline LVEF (HR 0.90, P<0.0001), the wall motion score index (WMSI) at rest (HR 4.02, P=0.0006), low-dose (HR 7.01, P<0.0001) and peak DSE (HR 4.62, P<0.0001), the extent of scar tissue (HR 1.39, P<0.0001) and the presence of ≥ 25% of segments with CR (HR 0.34, P=0.02). The best multivariable model to predict cardiac death included the presence of multi-vessel disease, the WMSI at low-dose DSE and the presence of CR in ≥ 25% of the severely dysfunctional segments (Chi-square 43.96, HR 9.62 CI 3.99-23.14, P<0.0001). Inclusion of ischemia to the model did not provide additional predictive value. **Conclusion.** The findings in the present study demonstrate that in patients with ischemic cardiomyopathy, the extent of CR is a strong predictor of long-term. Ischemia did not add significantly in the prediction of cardiac death after revascularization.



1081-92

### Superior Risk Stratification by Stress Echocardiography Compared to Exercise ECG: A Prospective Randomized Study in Patients Presenting the Hospital With Acute Chest Pain and Negative Troponin

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**Background:** Patients with coronary risk factors presenting to hospital with acute chest pain, non-diagnostic ECG's and negative troponin currently undergo exercise ECG (ExECG) for further risk stratification. Stress echocardiography (SE) has better accuracy than ExECG and is well established for the diagnosis of coronary artery disease (CAD). We hypothesized that SE is superior to ExECG in the risk stratification of such patients presenting to hospital with acute chest pain.

**Methods:** Patients presenting with acute chest pain were randomised to ExECG or SE. The test was performed within 24 hours of admission. Patients with a low post-test likelihood of CAD were discharged; those with a high post-test probability were considered for coronary angiography. All others were managed according to standard hospital protocols.

**Results:** A total of 433 patients underwent either ExECG (n=218) or SE (n=215). SE identified significantly more patients with a low post-test probability of CAD (77% v 33%, p<0.0001) and significantly fewer patients with an intermediate post-test likelihood of CAD compared to ExECG (3% v 44%; p<0.0001). Significantly more patients undergoing ExECG were referred for further tests for risk stratification compared to SE (52% vs 19%; p<0.0001). In total, 64 (15%) had flow limiting CAD demonstrated by coronary angiography of which 46 (11%) underwent a revascularisation procedure. Significant CAD was seen in fewer patients with a positive ExECG (64%) than with a positive SE (81%) (p=ns). Those patients discharged with a low post-test probability had low event rates (death, non-fatal myocardial infarction or revascularisation) for both ExECG and SE (3% vs 4% at mean FU of 7.8 and 7.0 months respectively).

**Conclusion:** SE is more accurate than ExECG in the risk stratification of patients presenting to hospital with acute chest pain, non-diagnostic ECG and a negative troponin. This implies that SE may be more cost-effective than ExECG for risk stratification in such patients.

1081-93

### Hemodynamic Response During Dobutamine-atropine Stress Echocardiography Is Influenced By Type Of Concomitant Beta-blocker Therapy

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**Background:** Cardioselective (CS) beta-blockers (BBLs) block beta1-receptors, while non-CS BBLs block both beta1- and beta2 receptors. Dobutamine is a partial beta1-agonist but also has action on beta2-receptors. The aim of this study was to compare the hemodynamic effects of dobutamine during dobutamine-atropine stress echocardiography (DSE) after treatment with CS BBLs and non-CS BBLs, including differences in long-term prognostic value.

**Methods:** 3,800 patients were evaluated for hemodynamic response, test results, and long-term cardiac events (cardiac death and myocardial infarction). Patients were followed for 6±4 years; those who underwent revascularization within 3 months (n=217), were lost-to-follow-up (n=50) or were not using BBLs were excluded.

**Results:** 1161 and 307 patients were using CS and non-CS BBLs, respectively. The heart rate response was greater in patients using CS BBLs at peak dose dobutamine (106 vs 100/min, p<0.002). This difference was absent after atropine infusion. However, systolic and diastolic blood pressure were higher in patients using non-CS BBLs (140 vs 131 and 75 vs 69 mm Hg, respectively). This difference persisted after atropine addition. The 6-year cardiac event rate was similar for both groups (20%).

**Conclusion:** The hemodynamic response to dobutamine during DSE is influenced by the type of concomitant beta-blocker therapy. Non-CS BBL therapy was associated with an inhibition in increase in heart rate, but an increase in systolic and diastolic blood pressure. However, no differences in cardiac outcome were observed.

1081-94

### Functional Improvement of Infarcted Segments During Exercise is Related to the Degree of Infarct Thickness

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**Background:** Viable myocardium in the outer myocardial layers may contribute to enhanced systolic performance during exercise. However, studies regarding the relationship between the degree of transmural infarct thickness and systolic functional improvement in dysfunctional segments during exercise have yet to be investigated. We sought to demonstrate the relationship between transmural hyperenhancement by Cardiac MRI (CMR) and functional improvement during exercise, demonstrated by exercise stress echocardiography, in patients with previous myocardial infarctions

**Method:** Fifteen patients undergoing primary angioplasty and stent implantation for AMI who demonstrated resting wall motion abnormality (akinesia to severe hypokinesia) of the infarct territory as assessed by 2D echocardiography at least 6 months after the initial PCI were studied. There were 7 cases of inferior MI, 7 cases of anterior MI and 1 case of posterolateral MI. All the patients had undergone cardiac MRI 3-16 days after the initial event. Symptom limited supine bicycle exercise stress echocardiography was performed at least 6 months after the initial event to assess functional recovery of the dysfunctional infarct segments at followup. For the MRI segmental analysis, the most basal and distal slices were excluded and each short axis slices were divided into 6 segments according to the coronary territory. The degree of transmural infarct thickness in dysfunctional segments were evaluated with CMR.

**Results:** A total of 150 segments of CMR imaging corresponding to the infarct related dysfunctional segments were analyzed. Segments with 0%, 1-25%, 26-50%, 51-75%, 76-100% hyperenhancement showed functional improvement in 15/15 (100%), 16/20 (80.0%), 3/39 (7.7%), 2/26 (7.7%), and 4/50 (8.0%), respectively, in the corresponding territory. Hyperenhancement of less than 25% was associated with sensitivity, specificity, positive predictive value, negative predictive value of 77.5%, 96.4%, 88.6%, and 92.2%, respectively.

**Conclusion:** In patients with reperfused STEMI, Functional improvement of dysfunctional infarct related segments during exercise may be predicted by CMR delayed hyperenhancement imaging.

## POSTER SESSION

### 1082 Contrast Echocardiography: Special Uses and Special Patients

Monday, March 07, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 11:00 a.m.-Noon

1082-79

### Ultrasound-mediated Transfection Of Intravenous VEGF<sub>165</sub> Plasmid-bearing Microbubbles Improves Microvascular Perfusion In Chronic Ischemic Skeletal Muscle

Howard Leong-Poi, Michael A. Kuliszewski, Michael Lekas, Alexander L. Klibanov, Duncan J. Stewart, Jonathan R. Lindner, St. Michael's Hospital, Toronto, ON, Canada, University of Virginia, Charlottesville, VA

**Background:** Ultrasound targeted microbubble destruction can potentially provide a safe and effective non-viral method of plasmid gene delivery. We hypothesized that VEGF<sub>165</sub> delivery by ultrasound-mediated destruction of plasmid-bearing microbubbles would improve microvascular perfusion in the presence of chronic ischemia.

**Methods:** The human VEGF<sub>165</sub> cDNA was sub-cloned into a vector for co-translation of both VEGF<sub>165</sub> and EGFP (enhanced green fluorescent protein) from a single mRNA. Chronic unilateral hindlimb ischemia was produced by ligation of the common iliac artery in 10 rats. Microvascular blood volume (MBV) and blood flow (MBF) in the proximal hindlimb muscles were assessed by contrast-enhanced ultrasound (CEU) at day 14, to allow for completion of endogenous angiogenesis. At day 14 post-ligation in 6 rats, the proximal ischemic hindlimb was exposed to intermittent high-power ultrasound during intravenous administration of VEGF<sub>165</sub> plasmid-bearing microbubbles (500 µg cDNA coupled to 1x10<sup>9</sup> cationic microbubbles) over 20 minutes. Repeat CEU assessment of MBV and MBF in the proximal hindlimb muscles was performed at day 28. Transfection was assessed by the extent of GFP/VEGF<sub>165</sub> positive cells on confocal microscopy of the hindlimb adductor muscles.

**Results:** Prior to VEGF<sub>165</sub> delivery, the normalized MBV and MBF for the ischemic muscle were similarly reduced in both VEGF<sub>165</sub>-treated and control non-treated animals. By day 28, VEGF<sub>165</sub>-treated ischemic muscles had significantly greater normalized MBV (1.00±0.17 vs 0.70±0.20, p<0.05) and MBF (1.02±0.17 vs 0.56±0.13, p<0.005), while non-treated ischemic muscles remained unchanged. Fluorescent confocal microscopy demonstrated a robust EGFP signal predominantly within the vascular endothelium in treated ischemic muscles, with little signal from non-ischemic muscles, or control animals.

**Conclusions:** We conclude that VEGF<sub>165</sub> delivery by ultrasound-mediated destruction of plasmid-bearing microbubbles is effective, and results in improved microvascular perfusion in the setting of chronic ischemic limb disease.

1082-80

### Modifications of Lipid Microbubble Shell Composition Affect Intravascular Kinetics

Sevgi Kilic, Rixiong Lu, Eric Tom, Joan Gretton, William R. Wagner, Flordeliza S. Villanueva, University of Pittsburgh School of Medicine, Pittsburgh, PA

**Background:** Ultrasound contrast microbubbles (µb) are increasingly used for diverse purposes requiring application-specific manipulation of µb features to optimize performance. For example, for targeted imaging, greater µb persistence could advantageously increase µb accumulation on the target with time. We thus hypothesized that µb formulation affects µb behavior in vivo.

**Methods:** The pharmacokinetics of 4 lipid-based perfluorocarbon gas-filled acoustically active µb were tested by intravital microscopy of rat cremaster microcirculation (n=5 rats/µb type). The basic fluorescent-labeled µb (A, 3.2±0.1 µm) comprised distearoyl phospho (DSP)-choline, DSP-ethanolamine-PEG-biotin and PEGylated surfactant with 1 fatty acid chain. µb B, C, and D were single variations of µb A: µb B (3.0±0.2 µm) used 2 fatty-acid chain PEGylated surfactant; µb C (2.5±0.1 µm) added propylene glycol (PG); µb D (2.4±0.2 µm) added PG + glycerin. Fluorescein-labeled Optison was used as a comparator. Rats received 1x10<sup>8</sup> µb i.v. bolus. The number of µb crossing an index venule vs. time was fit to an exponential model. Half-life (t<sub>1/2</sub>, min) and area under the curve (AUC) were derived. Pulmonary µb trapping was histologically measured post-mortem.

**Results:** t<sub>1/2</sub> and AUC differed among µb (ANOVA p<0.03): t<sub>1/2</sub> of the basic µb (µb A) was 1.1±0.1 (p=0.86 vs. Optison). Using 2- rather than 1- fatty acid chain surfactant (µb B) prolonged t<sub>1/2</sub> (1.7±0.4, p<0.01) and PG (µb C) similarly prolonged t<sub>1/2</sub> (1.6±0.1, p<0.001). PG + glycerin (µb D) did not change t<sub>1/2</sub> (1.1±0.1, p=0.77). Despite similar t<sub>1/2</sub> of µb B and C, µb C had the highest AUC (p<0.05), indicating more total circulating µb due to longer persistence during the pharmacokinetic elimination phase. This finding was consistent with the least lung retention of µb C seen on histology.

**Conclusion:** PG or a 2-fatty acid chain within a lipid  $\mu$ b shell increases  $t_{1/2}$ , possibly by creating secondary forces between lipid components that enhance *in vivo* stability. Despite the subcapillary size of all  $\mu$ b types tested, lung entrapment differentially varies with shell composition and hence affects total  $\mu$ b availability. These findings have implications for the design of ultrasound  $\mu$ b for differing applications.

#### 1082-81 Gene-Loading of Targeted Microbubbles Does Not Adversely Influence Binding Efficacy

Shivam Champeneri, Sarah Taylor, Alexander Klibanov, Jonathan R. Lindner, University of Virginia, Charlottesville, VA

**Background:** Ultrasound-mediated destruction of microbubble vehicles has been used to augment gene transfection and oligonucleotide delivery. Molecular targeting of microbubbles could improve the efficacy of gene delivery by increasing their local concentration, and by resulting in direct apposition of microbubbles against the vessel wall. We hypothesized that gene-loading of microbubbles would not interfere with microbubble targeting.

**Methods:** Cationic and neutral lipid microbubbles, both with and without a PEG-biotin arm were prepared. Coupling of plasmid to microbubbles was quantified by YOYO-1 gene-labeling and flowometry. Microbubble adhesion efficiency to plated streptavidin was evaluated in a flow chamber at shear stresses of 0.6 and 1.5 dynes/cm<sup>2</sup>. For all 4 preparations, adhesion was tested with or without incubation with plasmid. Adhesion *in vivo* was assessed by intravital microscopy of TNF-alpha-treated cremaster muscle of mice after IV injection of fluorescently-labeled ICAM-1-targeted or non-targeted cationic microbubbles, each with or without plasmid.

**Results:** An average of 0.04 pg of plasmid (4,800 plasmids) was charge-coupled to each cationic microbubble, and was not affected by the presence of PEG-biotin. Neutral microbubbles contained little plasmid (<0.002 pg). For flow-chamber studies, only microbubbles containing PEG-biotin attached to plated streptavidin. At all shear rates, attachment of plasmid-loaded cationic microbubbles was similar to that of neutral microbubbles. In the absence of plasmid, cationic microbubble binding was reduced by approximately half, probably reflecting interaction between biotin and the cationic shell. *In vivo* attachment of ICAM-1-targeted cationic microbubbles to inflamed venular endothelium was similar for microbubbles with and without plasmid (14±8 vs 13±9  $\mu$ m<sup>2</sup>). Attachment of non-targeted control microbubbles to the endothelium was not observed.

**Conclusions:** Coupling of plasmid DNA to the microbubble surface does not interfere with the ability to target microbubbles to disease-related molecules. The strategy of targeting cationic microbubbles may be useful for further augmenting gene delivery with ultrasound.

#### 1082-82 Stability of Echogenic Immunoliposomes Under Physiological Conditions

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**Background:** Echogenic immunoliposomes (ELIP) have great potential for targeted ultrasonic enhancement of atheroma/vascular endothelium. These agents also have potential for regional drug and gene delivery. For clinical use, formulations having optimal activity under physiologic conditions need to be established.

**Methods:** ELIP (phosphatidylcholine, phosphatidylethanolamine, phosphatidylglycerol, and cholesterol in a 69:8:8:15 mol % ratio) were made by lyophilization in the presence of mannitol. Stability (echogenicity as a function of time) was assessed in phosphate buffered saline and human serum (50%), as well as in the presence of bovine serum albumin (BSA) at 5 g/ml, and human IgG (10 mg/ml) (all at room temperature and 37°C). Ultrasound reflectivity was measured with a 20-MHz intravascular ultrasound catheter and quantified by computer-assisted videodensitometry.

**Results:** Protein had a marked effect on stability; the activity (after 3 hrs, room temperature) of liposomes exposed to serum, albumin, globulin, and no protein, was 90, 60, 30 and 10% respectively. Stability at 37°C was lower, but in the presence of serum, stability was quite good (75%) for up to an hour.

**Conclusions:** These data demonstrate that ELIP provide sufficient time for diagnostic imaging under physiologic conditions. Their ability to target molecular structures and potential to enhance drug and gene delivery expands our diagnostic and therapeutic approach to atherosclerotic cardiovascular disease.

#### 1082-83 Transmural Extent of Myocardial Necrosis Affects Accuracy of Myocardial Contrast Echocardiography in Patients After Reperfused Acute Myocardial Infarction

Roberta Montisci, Massimo Ruscazio, Cristiano Sarais, Luisa Cacciavillani, Francesco Corbetti, Anna Portale, Sara Pontarollo, Martina Perazzolo Marra, Enrico Bacchiaga, Andrea Pavei, Luigi Meloni, Sabino Iliceto, University of Cagliari, Cagliari, Italy, University of Padua, Padua, Italy

**Background:** Myocardial contrast echocardiography (MCE) can assess myocardial perfusion. In humans, no data exist on the impact of different myocardial alterations detectable after myocardial infarction (AMI) (transmurality extent and microvascular obstruction) on MCE accuracy in identifying infarcted myocardial segments. We investigate

the relationship between intravenous MCE and different myocardial structural alterations, as assessed by Gadolinium-DTPA contrast enhanced cardiovascular magnetic resonance (GE-MRI) in patients with AMI.

**Methods:** Fifty-six consecutive patients (mean age 60.6±10.5) with AMI underwent intravenous MCE study using real time mode during SonoVue injection or trigger mode during Levovist injection and GE-MRI 5±3 days after primary percutaneous coronary angioplasty. A 17-segment model of the left ventricle was used to analyze both MCE and GE-MRI. At GE-MRI we evaluated the extension of hyperenhancement (HE) to define the entity of myocardial necrosis transmural and of hypoenhancement, inside of HE zone, to detect microvascular obstruction.

**Results:** 837/935 (90%) myocardial segments were available for analysis after exclusion of segments with artifacts or attenuation. Among the 546 segments showing normal perfusion at GE-MRI 475 (87%) had normal perfusion at MCE. A MCE perfusion defect was present in 96/144 (67%) segments with transmural necrosis detected by GE-MRI (HE ≥ 75% of the thickness of the myocardial segment), and in only 50/128 (39%) segments with non transmural necrosis. MCE perfusion defect were detected in 46/69 (67%) myocardial segments with microvascular obstruction at GE-MRI. At logistic regression analysis transmural extent of myocardial necrosis was better associated with abnormal MCE pattern (OR 7.1, 95% CI 4.76-11.1; p<0.0001) than microvascular obstruction pattern (OR 2.38, 95% CI 1.28-4.34, p=0.006).

**Conclusion:** MCE capability in identifying myocardial necrosis after AMI is strongly influenced by its transmural extent, being non transmural necrosis rarely detected. The relationship among MCE findings and myocardial structural abnormalities must be taken into account in patients with reperfused AMI.

#### 1082-84 The Impact of Coronary Artery Stenosis Severity on the Induction of Wall Motion and Perfusion Abnormalities During Dobutamine Stress Myocardial Contrast Echocardiography

Abdou Elhendy, Thomas R. Porter, Feng Xie, Edward O'Leary, University of Nebraska Medical Center, Omaha, NE

**Aim of the study.** To assess the impact of coronary artery stenosis (CAS) severity on the induction of myocardial perfusion and wall motion abnormalities (WMA) during dobutamine stress echocardiography.

**Methods.** We studied 170 patients (age 60 ± 12 years, 71 women), who underwent dobutamine (up to 50  $\mu$ g/kg/min)-atropine stress test and quantitative coronary angiography. Wall motion analysis and myocardial contrast echocardiography (MCE) using repeated boluses of Optison or Definity, were performed at rest and at peak stress. Receiver-operating-characteristics (ROC) curves and areas under the curves were calculated to determine the cutoff percentage for CAS which optimized its performance as an indicator of the presence of a reversible perfusion or WMA.

**Results.** Percentage luminal diameter CAS was 50-69% in 108 and ≥70% in 159 arteries. ROC curves showed that stenosis severity ≥65% was the best cut-off that determined the occurrence of WMA, with an area under the curve of 0.85. WMA had a positive predictive value of 75% and negative predictive value of 80% for detecting stenosis ≥65%. A stenosis severity ≥55% was the best cutoff that determined the occurrence of perfusion abnormality. The area under the curve was 0.84. MCE had a positive predictive value of 78% and negative predictive value of 80% for detecting stenosis ≥55%.

**Conclusions.** Perfusion abnormalities occur with less severe CAS compared to WMA during dobutamine stress. Therefore, MCE is particularly more sensitive than wall motion analysis for the diagnosis of intermediate CAS.

#### 1082-85 Myocardial Perfusion Assessed by Real Time Contrast Echocardiography in Patients With Obstructive Hypertrophic Cardiomyopathy Referred for Percutaneous Transluminal Septal Myocardial Ablation

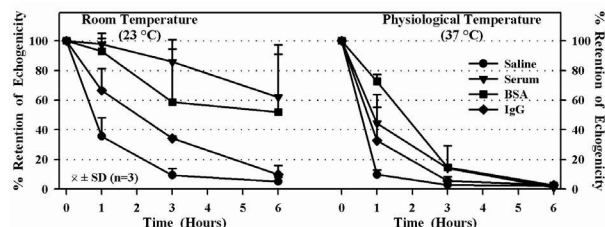
Chiara Pedone, Elena Biagini, Chris van der Lee, Wim B. Vletter, Folkert J. ten Cate, Bellaria Hospital, Bologna, Italy, Thoraxcenter Erasmus MC, Rotterdam, The Netherlands

**Background:** Microvascular dysfunction is a recognised feature of hypertrophic cardiomyopathy depending on a complex interplay of functional and anatomic mechanisms. In the present study we used myocardial contrast echocardiography (MCE) in patients with obstructive hypertrophic cardiomyopathy (HOCM) referred for percutaneous transluminal septal myocardial ablation (PTSMA) in order to assess myocardial perfusion pattern and its changes after the procedure.

**Methods:** Sixteen patients with HOCM (mean age 49±15 years, 69% males) referred for PTSMA underwent myocardial contrast echocardiography (MCE) before and 3.8±3.7 months after the procedure. MCE was performed using real time imaging during intravenous slow injection of SonoVue®. Myocardial blood velocity ( $\beta$ ) and semiquantitative measure of blood volume (homogenous, reduced or "patchy" and absent myocardial opacification) were assessed. The results were compared to eleven controls.

**Results:** In patients with HOCM myocardial blood velocity was significantly lower either before (0.17±0.04 vs. 0.50±0.34, p=0.006) or after PTSMA (0.23±0.07 vs. 0.50±0.34, p=0.02) compared to control group. A partial ("patchy") perfusion was present in all the HOCM patients and in none control. After PTSMA left outflow tract decreased from 86±19 to 18±21 (p<0.0001) and a significant symptomatic improvement was obtained consisting in reduction of NYHA class (2.5±1.1 to 1.1±0.3; p<0.0001) and resolution of angina. Myocardial blood velocity ( $\beta$ ) increased significantly after procedure (0.17±0.04 vs. 0.23±0.07 p=0.004); amount of change was not correlated with decrease of the gradient. Perfusion remained patchy after procedure in all the patients.

**Conclusions:** In patients with HOCM underwent PTSMA myocardial flow velocity, as assessed by MCE, was significantly slower compared to controls but it significantly increased after a successful procedure. Myocardial blood flow may represent an additional parameter to be used in the evaluation of PTSMA results.



1082-83

**1082-86 Feasibility and Perioperative Prognosis of Stress Echocardiography in Morbidly Obese Patients Undergoing Bariatric Surgery**

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**Background:** Morbid obesity (BMI  $\geq 35\text{kg/m}^2$ ) is a well-recognized major perioperative risk factor for cardiovascular morbidity and mortality. The role of stress echocardiography in perioperative risk stratification in the general population is well established. However, the role of stress echoes in evaluating high-risk morbidly obese patients with higher incidence of poor acoustic window is not known.

**Methods:** We studied 196 morbidly obese patients (weight  $345 \pm 97$  lbs, mean BMI  $53 \pm 11\text{kg/m}^2$ ) who underwent stress echocardiogram (SE) and subsequently gastric bypass surgery (average 30.5 days after SE). Dobutamine SE and exercise SE were performed using a standard protocol and wall motion analysis was performed using a 16 segments model. Optison, Definity or Imagent were used for endocardial border definition in patients with poor acoustic windows (<13/16 segments visualized).

**Results:** Population consisted of 78% women, with mean age  $44 \pm 10$  years, diabetes mellitus was present in 48%, hyperlipidemia in 58%, hypertension in 52%, obstructive sleep apnea in 37% and pulmonary hypertension in 12%. Dobutamine SE was performed in 155(79%) patients and exercise SE in 41 (21%). Mean EF was  $60 \pm 2.4\%$ . A satisfactory echocardiographic window (>13/16 segments) was observed in 66(34%) patients. 130(66%) patients had poor acoustic window. Contrast was used in 100 patients with poor acoustic window (Optison 28, Definity 63, Imagent 5), which improved the number of SE with poor to good window to 83%(conversion). SE was normal in 185(94.4%) and abnormal in 11(5.6%) patients.

No cardiac event (myocardial infarction or cardiac death) was observed in the follow up period of 843  $\pm$  246 days after the surgical procedure. Negative predictive value of the SE was 100%.

**Conclusion:** In the morbidly obese patients the incidence of poor acoustic window is high. Using contrast the conversion rate to satisfactory window is high. Stress echocardiography is feasible in morbidly obese patients. A normal stress echocardiogram portends a benign prognosis for perioperative cardiac events in high-risk morbidly obese patients.

**1083-72 Effect of Left Ventricular Geometry on Systolic Myocardial Velocity Gradient in Patients with Hypertension**

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**Background:** The left ventricular (LV) function in hypertensive heart has been evaluated by classifying LV geometry referring relative wall thickness (RWT) and LV mass index (LVMI). However, the relationship between LV geometry and myocardial contractility has not been clearly elucidated.

**Purpose:** To evaluate relationship between LV geometry and peak systolic myocardial velocity gradient (Gmax).

**Methods:** Ninety-three patients with essential hypertension were classified into 4 groups: normal geometry (N), concentric remodeling (CR), eccentric hypertrophy (EH) and concentric hypertrophy (CH). Gmax was calculated as the slope of regression line of myocardial velocity profile between endocardium and epicardium of the LV posterior wall obtained by tissue Doppler imaging technique.

**Results:** The Gmax showed negative relationship with LV end-diastolic dimension (LVd) ( $r = -0.61, p < 0.0001$ ). Multiple regression analysis demonstrated that the LVd was an independent factor for predicting Gmax. The LVd in CH and EH groups was significantly greater than that in N and CR groups ( $p < 0.001$ ). The LVMI was significantly greater in CH and EH groups than in the other groups ( $p < 0.001$ ). The Gmax was significantly smaller in CH group than in CR group ( $p < 0.05$ ), although there was no difference in RWT between two groups.

	N	CR	EH	CH
LVd (cm)	$4.8 \pm 0.5$	$4.2 \pm 0.4$	$5.7 \pm 0.7$	$4.9 \pm 0.7$
RWT	$0.39 \pm 0.05$	$0.56 \pm 0.10$	$0.38 \pm 0.06$	$0.56 \pm 0.09$
LVMI (g/m <sup>2</sup> )	$109 \pm 25$	$122 \pm 17$	$182 \pm 39$	$196 \pm 53$
Gmax (s <sup>-1</sup> )	$3.1 \pm 1.2$	$2.8 \pm 0.9$	$1.8 \pm 1.0$	$1.8 \pm 0.8$

**Conclusion:** In patients with essential hypertension, the Gmax worsened corresponding to increase in LV dimension even with similar wall thickness.

POSTER SESSION

**1083 Clinical Applications of Tissue Velocity and Strain**

Monday, March 07, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 11:00 a.m.-Noon

**1083-71 Acute Improvement in Myocardial Function Assessed by Strain and Strain Rate Echocardiography After Aortic Valve Replacement for Aortic Stenosis**

Noriaki Iwahashi, Satoshi Nakatani, Hideaki Kanzaki, Kazuaki Wakami, Haruhiko Abe, Takuya Hasegawa, Masakazu Yamagishi, Masafumi Kitakaze, Kunio Miyatake, National Cardiovascular Center, Suita, Japan

We investigated if strain and strain rate could be useful to detect changes in regional myocardial function in patients with aortic stenosis (AS) after aortic valve replacement (AVR).

**METHODS:** We studied consecutive 26 patients (70 $\pm$ 10 years) with severe AS 13 of whom underwent AVR. Peak strain, strain rate (systole, Ssr; early diastole, Esr; late diastole, Asr), time to peak strain (TS), time to peak systolic strain rate (TSsr) and time to peak early diastolic strain rate (TESr) of basal and mid segments in the apical 4-, 3- and 2-chamber views were measured and averaged before and 2weeks after AVR.

**RESULTS:** Peak strain and Ssr showed the best correlation with left ventricular (LV) ejection fraction (EF) ( $r = 0.78, r = 0.71$ , respectively, both  $p < 0.0001$ ). Esr and Asr showed significant correlations with LV mass index ( $r = 0.51, p < 0.01, r = 0.70, p < 0.0001$ , respectively), and TS, TSsr and TESr with aortic pressure gradient ( $r = 0.54, r = 0.47, r = 0.46$ , respectively, all  $p < 0.01$ ) before AVR. Although LV mass index and LV systolic function did not change significantly after 2 weeks (LV mass index,  $137 \pm 54$  vs.  $125 \pm 36$  g/m<sup>2</sup>; LVEF, 60 vs. 58%, both  $p = ns$ ), peak strain, and strain rates increased ( $p < 0.001$ ) and time to peak strain and strain rate shortened after AVR ( $p < 0.001$ ).

**CONCLUSIONS:** Strain and strain rate parameters seemed to relate LV function and AS severity. Strain and strain rate imaging could sensitively detect early changes in myocardial function after AVR before LV mass and LV function showed improvement.

	Strain(%)	Ssr(s <sup>-1</sup> )	Esr(s <sup>-1</sup> )	Asr(s <sup>-1</sup> )	Ts(sec/vRR)	TSsr(sec/vRR)	TESr(sec/vRR)	Peak PG(mmHg)
Pre AVR	$-12.6 \pm 2.6$	$0.7 \pm 0.1$	$0.7 \pm 0.2$	$0.9 \pm 0.2$	$418.8 \pm 41.1$	$251.6 \pm 45.3$	$513.6 \pm 26.5$	$100.9 \pm 35.1$
Post AVR	$-15.3 \pm 2.5$	$1.0 \pm 0.2$	$1.2 \pm 0.2$	$1.2 \pm 0.2$	$343 \pm 36.3$	$173.8 \pm 48.8$	$461 \pm 34$	$23.0 \pm 8.2$

RR=R-R interval on ECG

**1083-73 Effects of Weight Loss Following Gastric Bypass Surgery on Right and Left Ventricular Systolic and Diastolic Function**

Howard J. Willens, Simon C. Chakko, Patricia Byers, Eugenio Labrador, Juan C. Castrillon, Maureen H. Lowery, University of Miami School of Medicine, Miami, FL, Veterans Administration Medical Center, Miami, FL

**Background:** The effect of weight loss on cardiac function in obese patients has not been defined. This study evaluates the effects of significant weight loss following gastric bypass on right and left ventricular systolic and diastolic function using conventional Doppler echocardiography (DE) and tissue Doppler imaging.

**Methods:** We performed DE and tissue Doppler imaging on 14 patients (8 females), age  $44 \pm 10$  years, body mass index  $56 \pm 12$  kg/m<sup>2</sup>, before and 3-15 months after gastric bypass. DE parameters of interest included left ventricular end-diastolic diameter, fractional shortening, early (E) and late (A) mitral inflow velocities and (E/A) ratio. Peak systolic (S) and early (E) and late (A) diastolic tissue velocities were measured from the lateral and septal corners of the mitral annulus and lateral tricuspid annulus in the apical 4-chamber view.

**Results:** Patients lost an average of 39 kg (range 19-53). No significant changes in left ventricular end-diastolic diameter or fractional shortening were noted. Pre and post-surgical values compared using a paired t test are shown in the table. Although E and A decreased following surgery, E/A ratio increased. S' did not change in the left ventricle. E' at the lateral mitral annulus but not the septum increased. S' and E' at the tricuspid annulus increased significantly following surgery.

**Conclusions:** Substantial weight loss achieved with gastric bypass improves right ventricular systolic and diastolic function and left ventricular diastolic function.

Pre and post-surgical values for selected variables compared using paired t test

variable	pre-surgery	post-surgery	p value
S' tricuspid annulus (cm/s)	$8.7 \pm 2.6$	$10.4 \pm 2.3$	0.04
E' tricuspid annulus (cm/s)	$7.1 \pm 3.0$	$10.8 \pm 2.3$	0.001
E' lateral mitral annulus (cm/s)	$7.4 \pm 1.6$	$8.8 \pm 2.3$	0.046
E' septal mitral annulus (cm/s)	$6.3 \pm 1.6$	$7.5 \pm 1.8$	0.067
mitral E (cm/s)	$97 \pm 23$	$88 \pm 18$	0.026
mitral A (cm/s)	$76 \pm 14$	$60 \pm 18$	0.018
mitral E/A	$1.2 \pm 0.2$	$1.6 \pm 0.5$	0.01

**1083-74 Impaired Myocardial Contractility in Aortic Stenosis Demonstrated by Transmural Myocardial Strain Profile**

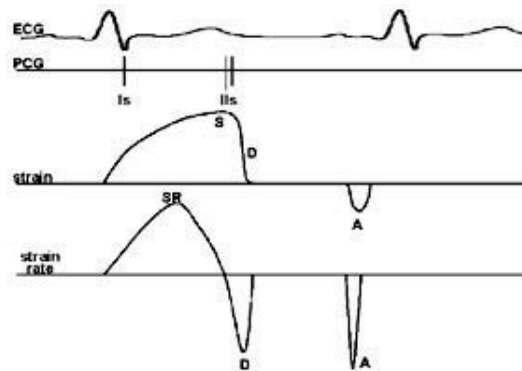
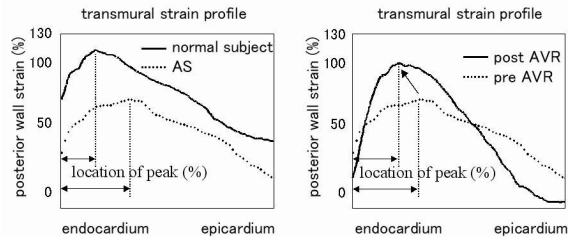
Takatashi Goto, Satoshi Nakatani, Takeshi Maruo, Kazuaki Wakami, Takuya Hasegawa, Hideaki Kanzaki, National Cardiovascular Center, Suita, Japan

**Background:** Myocardial dysfunction has been suggested in patients with aortic stenosis (AS) even with preserved left ventricular (LV) function.

**Methods:** To assess changes in myocardial function induced by reduction in pressure overload, we evaluated transmural myocardial strain profile (TMSP) using tissue strain M-mode imaging (Toshiba, TDI-Q) in 16 patients with AS undergoing aortic valve replacement (AVR) and 12 normals. Peak myocardial strain, its location (%distance of the wall thickness from the endocardium), and endocardial and epicardial-half strain were measured from systolic TMSP obtained at the short-axis LV posterior wall.

**Results:** LV fractional shortening was higher in AS than in normals ( $43\pm 4$  vs.  $37\pm 5\%$ ,  $p<0.05$ ). Peak ( $67\pm 24$  vs.  $111\pm 10\%$ ,  $p<0.0001$ ), endocardial-half ( $46\pm 14$  vs.  $99\pm 10\%$ ,  $p<0.0001$ ) and epicardial-half strain ( $27\pm 16$  vs.  $49\pm 14\%$ ,  $p<0.05$ ) were significantly lower and the location of peak strain was closer to the epicardium ( $33\pm 14$  vs.  $14\pm 8\%$ ,  $p<0.05$ ) in AS than in normals. Endocardial-half strain and aortic peak pressure gradient showed a significant negative correlation ( $r=-0.89$ ,  $p<0.0001$ ). After  $12\pm 3$  days of AVR, peak strain increased significantly ( $88\pm 29\%$ ,  $p<0.01$ ) and its location shifted to the endocardium ( $20\pm 12\%$ ,  $p<0.05$ ). Endocardial-half strain improved ( $66\pm 25\%$ ,  $p<0.01$ ) but epicardial-half strain did not change substantially ( $23\pm 18\%$ ,  $p=ns$ ).

**Conclusions:** In AS, reduced myocardial contractility was mainly found in the endocardial side that was improved by AVR.



1083-77

**Atrioventricular Conduction Time-Interval Measurement by Tissue Velocity Doppler: Validation of a Novel Technique and Correlation With ECG and Doppler Flow Measurements.**

Masaki Nii, Mikiko Shimizu, Kevin S. Roman, Igor Konstantinov, Jia Li, Andrew Redington, Edgar T. Jaeggi, The Hospital for Sick Children, Toronto, ON, Canada

**Background:** Accurate analysis of atrioventricular (AV) conduction time is crucial to detect evolving fetal AV block at an early stage. In the absence of real-time fetal ECG, pulsed Doppler (PD) interrogation of the LV in/outflow has become an established method of measuring fetal AV conduction time. Major drawbacks are its dependency on loading condition and fusion of E and A at faster heart rates. Longitudinal myocardial tissue velocity imaging (TVI) might be more useful in this regard.

**Objectives:** To study the relationship between electrical, hemodynamic and mechanical AV conduction time using surface ECG, PD and TVI at a physiological heart rate range of a human fetus.

**Methods:** In 15 open-chest pigs, incremental epicardial right atrial pacing was obtained at 100, 120, 140, 160, 180 and 200 bpm. For each heart rate, surface ECG and echo measurements were obtained. Myocardial velocities were determined at the AV groove of the right (RV), left (LV) ventricular free walls and the ventricular septum (IVS) using color-coded TVI. AV conduction times were measured by TVI (as interval between onset of A wave and isovolumic contraction spike); LV in/outflow PD (interval between onset of A wave and LVOT forward flow); and PR interval on surface ECG. We analyzed correlation between TVI, PD time intervals and PR intervals at different heart rates.

**Conclusion:** Although TVI derived AV conduction time underestimates PR interval, it has better correlation than PD method and is more applicable at higher heart rates.

Results: Correlation to PR interval and maximal HR

Modality	Correlation to PR interval	Bias	95% of limit of agreement
TVI-RV (N=53)	R=0.79 (P<0.0001)	10.35	-26.00-46.71
TVI-IVS (N=59)	R=0.84 (P<0.0001)	27.75	-14.29-69.78
TVI-LV (N=62)	R=0.75 (P<0.0001)	25.65	-11.94-63.24
LV PD (N=43)	R=0.32 (P=0.005)	-21.15	-69.11-26.80
Modality	Maximum HR (bpm) (range: median)	P value (TVI vs PD)	
TVI-RV	100-176.5; 140	0.02	
TVI-IVS	120-176.5; 140	0.0005	
TVI-LV	120.0-162.2; 140	0.01	
LV PD	93.8-142.9; 120		

1083-75

**Tissue Doppler Guided Optimization of A-V and V-V Delay of Biventricular Pacemaker Improves Response to Cardiac Resynchronization Therapy in Heart Failure Patients.**

Michael C. Chan, Mohsen Gaballa, Randy Williams, Soori Sivakumaran, Ken O'Reilly, Jan van der Linden, Lars-Ake Brodin, William Hui, Royal Alexandra Hospital, Edmonton, AB, Canada, Huddinge University, Stockholm, Sweden

**Background:** Only a proportion of heart failure patients respond to Cardiac Resynchronization Therapy (CRT). The optimal atrio-ventricular delay (A-V delay) and right to left ventricular delay (V-V delay) is unknown. We evaluated the impact of A-V delay as well V-V delay on left ventricular (LV) myocardial performance as assessed by Tissue Doppler Imaging (TDI). We also assessed if optimization of different pacing modalities might decrease the number of non-responder heart failure patients to CRT.

**Methods:** Forty five patients with class 3 and 4 ischemic heart failure and left bundle branch block, who received biventricular pacemaker (Medtronic) for >3 months, were deemed to be non-responders by quality of life (QoL) scoring, conventional echocardiography as well as 6 minute walk test.

TDI was acquired in these patients by Vivid-7 echo machine (General Electric Medical) at different pacing modalities in apical 2-, 3- and 4-chamber views. Myocardial systolic velocity (S), atrioventricular displacement (AV-disp.), ejection fraction (EF), strain (str.), time to peak velocity, time to peak velocity imaging (TSI), curved M-Mode of tissue tracking (C-TRACK) were obtained in LV walls simultaneously.

Different A-V delays (100, 130, 150, 170 msec) were chosen to minimize dyssynchrony in LV walls. At the optimal A-V delay, V-V delay was then tested at 4 msec, then increased stepwise to maximum 52 msec. Data were further analyzed off-line.

**Results:** The most favorable A-V delay for these patients to obtain the highest value for S, str, AV disp. was 130-150 msec ( $p<0.001$ ). At this A-V delay, better synchrony was obtained as shown by C-TRACK. The common optimal V-V delay was 24-28 msec. Thirty eight (85%) patients improved significantly after optimization of CRT, as shown by QoL ( $p<0.01$ ), and EF ( $p<0.01$ ).

**Conclusion:** Tissue Doppler Imaging may play an important role in optimization of CRT. An A-V delay of 130-150 msec, as well as V-V delay of 24-28 msec may generally be used to improve LV performance and decrease the number of non-responder patients.

1083-76

**Quantitative and Direct Assessment of the Left Atrial Reservoir Function Using Tissue Strain Imaging**

Tomotsugu Tabata, Hideji Tanaka, Hirotsugu Yamada, Yoo Saito, Kenji Harada, Masahiro Nomura, Susumu Ito, The University of Tokushima Graduate School of Medicine, Tokushima, Japan

**Background:** The evaluation of the left atrial (LA) reservoir function using pulmonary venous flow (PVF) velocities was influenced by the loading conditions. The tissue strain imaging (TSI) could potentially evaluate LA reservoir function directly by measuring systolic strain (S) and strain rate (SR).

**Purpose:** To assess LA reservoir function in the normal hearts using TSI.

**Methods:** Transesophageal echocardiography was performed in 18 normal volunteers (32 ± 5yrs). From the recording of Doppler PVF profiles, we measured systolic (PVS<sub>vt</sub>) and diastolic (PVD<sub>vt</sub>) velocity time integrals and their systolic fraction [PVS<sub>vt</sub>/(PVD<sub>vt</sub>+PVS<sub>vt</sub>)]. The color tissue Doppler image including LA lateral wall was acquired, and the peak systolic S and SR were analyzed off-line (TDI-Q, Toshiba, Japan). The preload was increased by the lower body positive presser device (LBPP).

**Results:** 1) LA strain and strain rate profiles at rest were obtained as shown in the figure. 2) The LA area, PVS<sub>vt</sub> (10.2 vs 15.7cm), PVD<sub>vt</sub> (6.8 vs 8.0cm) and systolic fraction (0.53 vs 0.66) significantly increased reflecting preload increase by LBPP. 3) Corresponding to those changes, the peak systolic S (0.80 vs 1.01,  $p<0.001$ ) and SR (3.5 vs 5.6s<sup>-1</sup>,  $p<0.01$ ) significantly increased.

**Conclusions:** The peak systolic S and SR increased corresponding to the increase in LA preload as evidenced by changes in the PVF velocities. The parameters obtained from TSI can be potentially applied for quantitative and direct assessment of the LA reservoir function.

1083-78

**Strain Imaging Is Useful for Assessing Acute Hemodynamic Response to Cardiac Resynchronization Therapy in Nonischemic Dilated Cardiomyopathy**

Takahide Ito, Michihiro Suwa, Yasuhiko Sakai, Yasunobu Tokaji, Satoshi Yamamoto, Yasushi Kitaura, Osaka Medical College, Takatsuki, Japan

**Background:** Evidence has shown that cardiac resynchronization therapy (CRT) induces clinical and hemodynamic improvement in end-stage heart failure patients, although noninvasive method for assessing the efficacy of CRT remains to be validated. We performed newly developed echo-Doppler technique strain imaging simultaneously with hemodynamic study in patients with nonischemic dilated cardiomyopathy and intraventricular conduction delay (QRS duration>140 ms).

**Methods:** Strain imaging was performed on 14 patients (10 men, mean age 67±15) during 2 different pacing modes (right ventricular pacing [RV] and biventricular pacing [CRT]) with the pacing rate fixed at 80 beats/min. The time to peak negative strain was measured from 16 regions of interest in apical 2-, 4-chamber, and long axis views, and the standard deviation of this time-interval was calculated as an index of intraventricular asynchrony. The left ventricular (LV) +dp/dt was measured noninvasively with continuous wave Doppler.

**Results:** With the pacing mode changed from RV to CRT, the asynchrony index (from 95±27 to 63±16,  $p<0.01$ ) and QRS duration (from 186±22 ms to 135±27,  $p<0.01$ ) decreased significantly. This finding was associated with significant changes in pulmonary wedge pressure (from 15±7 mmHg to 12±8,  $p<0.05$ ), LV +dp/dt (from 732±211 mmHg/ms to 957±285,  $p<0.01$ ), and LV ejection fraction (from 31±7% to 35±7,  $p<0.01$ ). The

asynchrony index correlated significantly with LV +dp/dt ( $r=-0.52$ ,  $p<0.01$ ), LV ejection fraction ( $r=-0.42$ ,  $p<0.05$ ), and cardiac index ( $r=-0.41$ ,  $p<0.05$ ). Conclusions: Strain imaging is useful for assessing intraventricular asynchrony and hemodynamic response for patients undergoing CRT.

## POSTER SESSION

## 1084 Cardiac Magnetic Resonance Imaging: Clinical Studies

Monday, March 07, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 11:00 a.m.-Noon

### 1084-63 Detection of Procedural Myocardial Necrosis After Surgical or Percutaneous Revascularization Using Contrast-Enhanced Magnetic Resonance Imaging

*Olga Bondarenko*, Aernout M. Beek, Mark B.M. Hofman, Cees A. Visser, Albert C. van Rossum, VU University Medical Center, Amsterdam, The Netherlands

**Background:** Delayed contrast-enhanced (DCE) MRI may be more accurate in evaluating the incidence of procedural myocardial infarction in patients undergoing revascularization than cardiac enzymes and electrocardiographic criteria.

**Methods:** Thirty-two patients with chronic ischemic left ventricular dysfunction underwent cine MRI for assessment of global left ventricular function and DCE MRI for assessment of total myocardial scar tissue mass 1 month before and 3 months after surgical or percutaneous revascularization.

**Results:** None of the patients had electrocardiographic evidence of procedure related myocardial infarction. CK-MB measurements were obtained peri-operatively in 24 patients. In 11 of them there was biochemical evidence of myocardial infarction (CK-MB elevation > 3 times upper limit of normal), whereas 11 patients showed no significant release of cardiac enzymes. In both groups new scar tissue was detected by DCE MRI at follow-up:  $2.4\pm 4.4$  g in patients with infarction vs.  $1.9\pm 2.8$  g in patients without infarction ( $p=NS$ ). The mean scar tissue mass for the entire patient group increased at follow-up to  $18\pm 14$  g vs.  $16\pm 12$  g at baseline ( $p=0.005$ ). The mean EF did not improve after revascularization:  $39\pm 12\%$  vs.  $39\pm 12\%$  before revascularization. There was a moderate but significant inverse relation between the change in the total scar tissue mass and the EF change after the revascularization ( $r=0.47$ ,  $p=0.007$ ).

**Conclusion:** DCE MRI is superior to ECG and CK-MB measurements for detection of revascularization procedure related myocardial necrosis.

### 1084-64 Magnetic Resonance Imaging T<sub>2</sub> Measurements Of Iron Overload In Beta-thalassemia Major: Relation To Exercise Capacity And Cardiac Function.

*Athanasios Trikas*, George Latsios, Costas Tentolouris, Gregory Kotoulas, Eugene Vgonza, Dimitris Tousoulis, Christos Pitsavos, Christodoulos Stefanadis, University of Athens, Athens, Greece

**Background:** Previous studies have shown that in beta-thalassemia major (TM) the assessment of left ventricular (LV) function with echocardiography alone does not accurately reflect the patient's cardiac iron overload (CIO) and clinical status. To compare exercise capacity (EC) with common echocardiographic-Doppler (ED) indices of LV systolic and diastolic function, and CIO in TM, we studied 40 pts (19 women and 21 men, mean age  $29.6\pm 5.3$  years), who were in stable condition while receiving regular transfusions. Of the 40 pts, 23 were asymptomatic and 17 in functional class NYHA II-III.

**Methods:** Each subject underwent, 3 days after transfusion, a complete ED study followed by a cardiopulmonary exercise testing and magnetic resonance imaging (MRI) examination. T<sub>2</sub> proton relaxation time measurements were obtained in the LV of pts using a dual echo Turbo Spin Echo (TSE) sequence (Phillips ACS-NT 1.5T, TR=2000ms, TE<sub>1</sub>=8ms, TE<sub>2</sub>=40ms). LV dimensions and walls, as well as ejection fraction (EF) were measured from ED study. Peak velocities of early and late diastolic filling of LV were measured from Doppler transmitral flow and their E/A ratio was calculated. EC was assessed by peak oxygen consumption (VO<sub>2</sub>max, ml/kg/min) and anaerobic threshold (AT, ml/kg/min).

**Results:** The following were observed: 1) symptomatic pts had lower VO<sub>2</sub>max and AT than did asymptomatic ( $18.7\pm 1.8$  vs  $26.2\pm 3.2$  -  $p<0.001$  and  $12.4\pm 2.0$  vs  $15.9\pm 1.8$  -  $p<0.001$ , respectively), 2) no significant correlation was found between LV T<sub>2</sub> measurements and LV dimensions and walls or EF and E/A ratio, and 3) a statistically strong significant linear correlation was observed between LV T<sub>2</sub> and VO<sub>2</sub>max and AT measurements ( $r=0.80$  -  $p<0.01$  and  $r=0.82$  -  $p<0.01$ , respectively).

**Conclusions:** In patients with beta-thalassemia major LV T<sub>2</sub> measurements, an index of iron overload determined through MRI, is closely related to exercise capacity and not to echocardiographic parameters. Conventional indices of cardiac function can only detect advanced disease, while exercise capacity parameters seem to be better markers for predicting disease progression due to myocardial iron overload.

## 1084-65

## Delayed Hyperenhancement Magnetic Resonance Imaging Is Useful in Predicting Functional Recovery of Nonischemic LV Systolic Dysfunction

*Sungha Park*, Se-Joong Rim, Byoung Wook Choi, Young-Guk Ko, Seok-Min Kang, Jong-Won Ha, Yangsoo Jang, NamSik Chung, Won-Heum Shim, Kyu-Ok Choe, Seung-Yun Cho, Yonsei University College of Medicine Yonsei Cardiovascular Center, Seoul, South Korea

**Background:** About 1/4 of the patients with recent onset, non ischemic Left Ventricular(LV) systolic dysfunction improve spontaneously with medical treatment. However the predictors for the future improvement in LV function are not yet known. Recently, cardiac MRI(CMR) has been suggested to reflect myocardial fibrosis in dilated cardiomyopathy. We hypothesized that the presence of myocardial fibrosis, assessed by CMR, may predict the reversibility of non ischemic LV systolic dysfunction.

**Methods:** CMR was performed on 37 patients with new onset of non ischemic systolic heart failure. Seventeen patients showed absence of delayed hyperenhancement(Group 1, age:  $53.2\pm 14.6$ , M:F=9:8) while 20 patients demonstrated delayed hyperenhancement on CMR imaging(group2, age:  $59.0\pm 13.6$ , M:F=15:5) The two study groups were compared in terms of the functional recovery of LV systolic function to at least preserved status(LVEF > 45%) at followup.

**Results:** There was no significant difference in the duration until follow-up echocardiography.(group 1:  $7.3\pm 3.2$  months group 2:  $9.1\pm 5.6$  months) Thirteen out of 17 patients(76.5%) in group 1 demonstrated functional recovery whereas only 2 out of 20 patients(10.0%) in group 2 demonstrated functional recovery. Absence of hyperenhancement predicted functional recovery with sensitivity, specificity, positive predictive value, negative predictive value of 86.7%, 81.8%, 76.5%, and 90.5%, respectively. There were no significant difference between group 1 and group 2 for the initial LV end diastolic dimension(LVEDD)[ $64.2\pm 6.2$ mm vs  $66.9\pm 9.2$ mm], LV end systolic dimension(LVESD)[ $55.8\pm 6.6$ mm vs  $58.9\pm 9.3$ mm], LVEF( $28.5\pm 7.4\%$  vs  $24.9\pm 8.1\%$ ) and followup LV end diastolic dimension(LVEDD)[ $56.0\pm 7.5$ mm vs  $61.9\pm 13.0$ mm,  $p=0.102$ ], but there were significant differences for follow-up LVESD( $43.3\pm 9.8$ mm vs  $52.0\pm 13.9$ ,  $p=0.038$ ) and LVEF( $45.9\pm 12.8\%$  vs  $33.1\pm 13.1\%$ ,  $p=0.005$ ).

**Conclusion:** Delayed hyperenhancement, assessed by CMR, is associated with functional recovery in non-ischemic LV systolic dysfunction. CMR may be clinically useful in predicting functional recovery of non-ischemic LV systolic dysfunction.

## 1084-66

## Myocardial Structural Correlates of Late Persistence of ST-Segment Elevation in the Subacute Stage of Myocardial Infarction

*Massimo Napodano*, Luisa Cacciavillani, Francesco Corbetti, Angelo Ramondo, Giuseppe Tarantini, Renato Razzolini, Elisabetta Grolla, Sabino Iliceto, University of Padova, Padova, Italy

**Background.** The persistence of ST-segment elevation (STE) lasting for a long time after acute myocardial infarction (AMI) has been typically ascribed to left ventricular aneurysm formation. However this conclusion is controversial, and the pathological basis of late persistent STE is still lack. Contrast-enhanced magnetic resonance imaging (CMR) allows precise delineation of transmural and spatial extent of myocardial necrosis and microvascular obstruction. The purpose of this study was to evaluate the myocardial structural abnormalities underlying late persistence of STE, using contrast cardiac magnetic resonance.

**Methods:** 72 patients who underwent direct percutaneous coronary intervention for their first AMI were studied by CMR. The late STE was defined by the persistence of at least 2 mm in two or more leads on pre-discharge ECG. In each patient, the presence and extent of myocardial necrosis (late hyperenhancement) and microvascular obstruction (hypoenhancement) were assessed on a 17-segment model. For each segment, the transmural extent of hyperenhancement and hypoenhancement were scored from 0 to 4, and the total amount of hyperenhancement and hypoenhancement was expressed as the sum of score in each segment divided by the number of segments assessed.

**Results:** Overall 72 patients, 27 (37.5%) showed late persistence of STE and 45 (62.5%) did not. Patients with late persistence of STE was more often diabetics ( $p=0.01$ ), had more anterior infarction ( $p=0.001$ ) and had longer ischemic time ( $p=0.001$ ). At CMR patients with late STE had higher number of segments exhibiting hyperenhancement ( $p<0.0001$ ), higher hyperenhancement score ( $p<0.0001$ ). Likewise, STE group had higher number of hypoenhanced segments ( $p<0.0001$ ), higher hypoenhancement score ( $p<0.0001$ ). In a multivariate model the extent of hypoenhancement, but not the extent of hyperenhancement, was an independent predictor of late persistence STE.

**Conclusions:** Late persistence of ST segment elevation after myocardial infarction is related with a larger extent of necrosis and microvascular obstruction as assessed by CMR. The microvascular obstruction is an independent predictor of late persistence of ST segment elevation.

## 1084-67

## Heterogeneity in Anatomical and Functional behavior of Reperfused Myocardium after Primary Angioplasty for Acute Myocardial Infarction; a contrast-enhanced Magnetic Resonance Imaging study

*Timo Baks*, Robert-Jan van Geuns, Elena Biagini, Piotr Wielopolski, Nico Mollet, Filippo Cademartiri, Willem van der Giessen, Gabriel Krestin, Dirk Duncker, Pim de Feyter, Erasmus Medical Center, Rotterdam, The Netherlands

**Background:** Early restoration of coronary blood flow in patients with acute myocardial infarction (AMI) reduces infarct size and preserves left ventricular function, but the effect of early reperfusion on ischemic myocardium and eventually infarct resorption is not well understood. Therefore, we performed serial contrast-enhanced Magnetic Resonance Imaging (ce-MRI) in patients who underwent successful primary angioplasty for first AMI.

**Methods:** In 22 patients, cine-MRI, first-pass perfusion and delayed enhancement (DE) imaging was performed at 5 days and 5 month after primary angioplasty for first AMI. End

diastolic wall thickness (EDWT) and segmental wall thickening (SWT) was quantified in 16 segments per patient. Infarct size was quantified on DE images and myocardial perfusion was evaluated qualitatively and scored on a 3-points scale.

**Results:** Myocardial infarct size decreased with 31% from a mean of 35±21 gram to 24±17 gram (26% to 20% of left ventricular mass; p<0.001). Infarct size at 5 days was a good predictor for infarct size at 5 month post AMI (r=0.92; p<0.001). At 5 days post AMI, EDWT was increased in dysfunctional myocardial segments with a normal (restored) microvascular perfusion (8.7±1.8mm; SWT=21±15%) as compared to remote (non-ischemic) myocardium (8.3±1.7mm; p=0.026; SWT=80±28%). EDWT in myocardium with a severe perfusion defect was not significantly increased (8.5±1.6mm; p=NS; SWT=11±12%). At 5 months, EDWT became comparable for all segments but decreased in segments with a severe perfusion defect (8.5±1.6mm to 6.4±1.3mm; p<0.001; SWT=17±20%).

**Conclusions:** Infarct size decreased with 31% between 5 days and 5 month after AMI. Increased EDWT early after AMI suggests restored perfusion of the myocardium.

1084-68

#### Delayed Enhancement is a Better Predictor than Perfusion Imaging of left Ventricular Function at 5 Months After Primary Angioplasty for Acute Myocardial Infarction: a contrast-enhanced Magnetic Resonance Imaging study

Timo Baks, Robbert-Jan van Geuns, Piotr Wielopolski, Willem van der Giessen, Nico Mollet, Filippo Cademartini, Gabriel Krestin, Patrick Serruys, Dirk Duncker, Pim de Feyter, Erasmus Medical Center, Rotterdam, The Netherlands

**Background:** We investigated whether myocardial perfusion or delayed enhancement (DE) imaging with contrast-enhanced Magnetic Resonance Imaging (ce-MRI) performed 5 days after successful angioplasty for acute myocardial infarction (AMI) is a better predictor of segmental wall thickening (SWT), ejection fraction (EF), and end systolic volume (ESV) at 5 months post AMI. Myocardial perfusion and DE imaging have not yet been evaluated in a well-defined homogenous group of patients with successful primary angioplasty for AMI.

**Methods:** Twenty-two patients underwent cine-MRI, first-pass perfusion and DE imaging 5 days after placement of a drug-eluting stent in the infarct related coronary artery. Regional myocardial perfusion was scored on a 3 points scale and the transmural extent of DE on a 5 points scale in 16 segments per patient. A per patient perfusion score was calculated and consisted of a summation of all segmental scores. Myocardial infarct mass was quantified by measuring the volume of DE. At 5 months after AMI, cine-MRI was performed and SWT, EF and ESV were quantified.

**Results:** The segmental DE scores correlated better than the segmental perfusion scores with quantified SWT at 5 months post AMI (r=0.51; p<0.001 versus r=0.37; p<0.001). The acute myocardial infarct mass correlated better than the calculated perfusion score with EF (r=0.80; p<0.001 versus r=0.48; p=0.02) and ESV (r=0.88; p<0.001 versus r=0.37; p=0.09) at 5 months.

**Conclusions:** DE imaging with ce-MRI in patients 5 days after reperfused AMI is a better predictor of SWT, EF and ESV at 5 months after AMI than perfusion imaging.

1084-69

#### Cardiac Magnetic Resonance Imaging for the Detection and Quantification of Symptomatic CAD

Johannes Rieber, Armin Huber, Isabelle Erhard, Thomas M. Schiele, Maximilian Reiser, Volker Klaus, Medizinische Klinik, Ludwig-Maximilians-University, Munich, Germany, Institute for Clinical Radiology, Ludwig-Maximilians-University, Munich, Germany

Cardiac magnetic resonance imaging (CMRI) is a rapid evolving method for the noninvasive assessment of symptomatic coronary artery disease (CAD). Beneath morphological assessment by quantitative coronary angiography (QCA) the pressure derived fractional flow reserve (FFR) is the well established new gold standard to invasively evaluate the functional severity of coronary lesions. The aim of our study was to assess the ability of CMRI to detect flow limiting coronary stenoses compared to the invasive reference standards QCA and FFR.

**Methods:** 43 Patients with suspected CAD received a CMRI (Siemens Sonata, Erlangen, GE; IPAT) within one week of the scheduled CA. Signal intensity curves of the first pass of a Gadolinium-DTPA bolus at rest and during hyperemia (Adenosine 140µg/kg/min i.v.) were investigated and input function corrected signal intensity curve's upslope (US) was determined for each myocardial perfusion area using an 18 segment model. The myocardial perfusion reserve (MPR) was calculated as US stress and US rest ratio. A coronary artery with lesions < 50% diameter reduction as assessed by standardized QCA was stated as normal (n=42). A coronary lesion > 50% and FFR (PressureWire, Radi, SE) > 0.75 was called intermediate (n=64). If a diameter reduction >50% and FFR ≤ 0.75 was present, the lesion was defined as severe (n=23). A ROC analysis was carried out to evaluate the best cut off value.

**Results:** 129 perfusion areas (43 LAD; 43 LCx and 43RCA) were evaluated. Mean MPR was 1.7 (range 1.0-3.5). Mean MPR was significantly different between the regions supplied by a normal coronary vessel (2.08±0.55) or a vessel with an intermediate (1.65±0.55) or severe stenosis (1.3±0.60) (p<0.001). However, a large overlap between these groups was observed. ROC analysis revealed a MPR of 1.58 for best discrimination between severe and normal to intermediate stenosed coronary arteries. At this threshold sensitivity reached 68% and specificity 78%.

**Conclusion:** In this study CMRI could demonstrate its ability to non invasively identify significant coronary lesions at a reasonable sensitivity and specificity. ROC analysis identified a MPR value of 1.58 for best accuracy.

1084-70

#### Serum Brain Natriuretic Peptide Is a Marker of Myocardial Fibrosis in End Stage Renal Failure as Demonstrated by Cardiac Magnetic Resonance Imaging

Patrick B. Mark, Nicola Johnston, Kevin G. Blyth, Thomas E. Martin, John E. Foster, Henry J. Dargie, Alan G. Jardine, Western Infirmary, Glasgow, United Kingdom

**Background:** Patients with end stage renal failure (ESRF) have an increased cardiovascular mortality with left ventricular (LV) disorders being a marker of poor outcome. Contrast enhanced cardiac magnetic resonance imaging (CMR) assesses LV dimensions and non-invasively identifies myocardial fibrosis. Serum brain natriuretic peptide (BNP) has been shown to correlate with LV mass and patient survival in ESRF. We studied the relationship between BNP, LV dimensions and the presence of myocardial fibrosis as assessed by CMR.

**Methods:** 84 ESRF patients from the renal transplant list (54 men, median age 54, range 27-72) underwent CMR (1.5T scanner, Siemens Sonata) with LV dimensions assessed by cine stack. Further images were acquired following i.v. gadolinium-DTPA using an inversion recovery fast low angle shot sequence, with images assessed for the presence and extent of late gadolinium enhancement (LGE) indicating myocardial fibrosis. Serum was taken for BNP (Shionoria) pre-scan.

**Results:** There was an overall correlation between serum BNP and LV mass/Body Surface Area (r=0.24, p<0.05), and end systolic volume/Body Surface Area (r=0.35, p<0.01) but not ejection fraction (r=-0.19, p=0.09). 25 (29.8%) of patients had evidence of myocardial fibrosis indicated by positive LGE. Serum BNP correlated with mass of myocardial fibrosis indicated by LGE (r=0.33, p<0.01). In the sub group of patients with LGE there was stronger correlation between serum BNP and LV mass/Body Surface Area (r=0.56, p<0.01), end systolic volume/Body Surface Area (r=0.41, p<0.05) and negative correlation with ejection fraction (r=-0.42, p<0.05). There was no relationship between BNP and LV dimensions in the sub group of patients without LGE. The range for BNP in ESRF was wide (LGE positive - 0-1089pg/ml; negative - 0-2085pg/ml).

**Conclusions:** Myocardial damage indicated by LGE is common in ESRF. The relationship between BNP and myocardial dimensions in ESRF is dependant on the presence of myocardial damage and suggests that BNP may be raised either in response to, or as a marker of myocardial fibrosis in ESRF. The wide range of serum BNP also suggests impaired BNP clearance.

### ORAL CONTRIBUTIONS

805

#### Contrast Echocardiography: New Tools and Comparisons to Other Techniques

Monday, March 07, 2005, 9:15 a.m.-10:30 a.m.  
Orange County Convention Center, Room 230B

9:15 a.m.

805-3

#### Relative Myocardial Blood Volume: A Variable for the in Vivo Distinction Between Physiologic and Pathologic Left Ventricular Hypertrophy in Humans

Andreas Indermuehle, Rolf Vogel, Pascal Meier, Christoph Staehli, Christian Seiler, University Hospital, Bern, Switzerland

**Background:** Left ventricular hypertrophy (LVH) in hypertensive heart disease (HHD) is a pathologic adaptation to increased wall stress. Vascular density in myocardial biopsies is reduced due to extracellular and periarterial collagen deposition. However, it is unknown whether vascular density keeps pace with LVH in athlete's heart (AH), which is supposed to be a physiologic adaptation.

**Methods:** Four groups were studied. 14 endurance athletes with AH (mean age 32±9 years) were matched for age and gender to 14 patients with HHD (32±9 years). As control groups 11 healthy volunteers (32±3 years) and 11 professional football players (27±4 years) without LVH were examined. LVH was defined as ventricular wall thickness greater than 12 millimetres. Myocardial contrast echocardiography was performed by means of a continuous venous ultrasound contrast agent infusion. Vascular density, i.e., relative myocardial blood volume (rMBV, ml/ml), its exchange rate (ER, 1/min) and absolute perfusion (AP=rMBVxER/1.05g/ml, ml/min/g) at rest and during adenosine stress were derived from ultrasound contrast agent refill curves following its ultrasound-induced destruction. The ratio of AP(stress)/AP(rest) yielded coronary flow reserve.

**Results:** Left ventricular mass index was not significantly different in AH and HHD 130 (17) and 140 (31) g/m<sup>2</sup>, respectively. rMBV at rest in AH (0.141 (±0.019)) was significantly higher than in HHD (0.090 (±0.016) p<0.0001) and controls (0.128 (±0.029) p<0.026) but no significant difference was found compared to football players (0.131 (±0.027) p<0.096). An rMBV ≥0.11 distinguished between AH and HHD with a sensitivity of 95% and a specificity of 97%. Coronary flow reserve was significantly higher in endurance athletes (5.2 (±1.7)) than in HHD (2.8 (±0.8) p<0.0001), in controls (3.6 (±0.9) p<0.0001) and in football players (4.2 (±1.5) p<0.0028).

**Conclusions:** Vascular density as obtained by rMBV using myocardial contrast echocardiography is significantly higher in AH than in HHD demonstrating the physiologic nature of LVH in AH. For the first time, it was possible to measure in vivo the relative fraction of vascular volume.

805-4

**Novel Imaging Method for Myocardial Contrast Echocardiography Using Intravenous Contrast Agent, Levovist™: Usefulness of Myocardial Blood Volume Map In Patients With Ischemic Heart Disease**

Eiichi Nagashima, Takahiro Ota, Keiko Maeda, Hitomi Kawano, Kenji Shimeno, Keiji Nagae, Shiro Yanagi, Kazuyoshi Hirota, Junichi Yoshikawa, Fuchu Hospital, Izumi, Japan, Osaka City University School of Medicine, Osaka, Japan

**Background:** Myocardial contrast echocardiography using iv. contrast agent provides increasing diagnostic value for noninvasively detecting myocardial perfusion. A 1.5 harmonic imaging has been reported to minimize tissue signal of the background, enabling clear visualization of myocardial perfusion. Novel quantitative method of myocardial blood volume map (VoluMap®) was designed to evaluate myocardial perfusion, expressing the contrast intensity as color coded map. We tested the usefulness of VoluMap to evaluate myocardial perfusion in patients (pts) with old myocardial infarction (OMI) and angina pectoris(AP) using Levovist®(LEV) and compared to TI SPECT.

**Method:** We examined 20 pts; 13 OMI and 7 suspected AP (age 65.8±4.1 yrs, 15 males). A 1.7/2.5MHz transducer equipped with SSA-770A (Toshiba Ltd.) was used to image myocardial performance of LV during MCE with injection of LEV. Series of intermittent images (1:1, 1:6) were recorded to assess myocardial enhancement during iv. infusion (3.0 ml/min) of LEV. New calibration method to quantitate myocardial volume such as relative myocardial contrast score (RMS, dB) was calculated as the difference of contrast intensity of myocardium minus that of adjacent LV cavity by VoluMap. RMS less than -18dB indicating poor perfusion assigned as cold color mapping. Based on the VoluMap image, myocardial enhancement was scored as good (3) to none (0) in each segment(seg). SPECT was performed in all pts and scored visually and compared with RMS.

**Result:** A 236/240 segs (98%) were scored in SPECT and 210/240 segs (88%) were analyzed and color mapped successfully. In pts with OMI, 40/40 (100%) infarct segs were scored poor perfusion in SPECT and 38/40 segs in VoluMap.

Mean contrast score correlated well with SPECT score in OMI (1.8±0.7 vs. 2.2±0.8 r=0.752). In pts with AP (n=4), 46/48 segs (95%) by SPECT and 40/48 segs by VoluMap was successfully identified as myocardial ischemia.

**Conclusion:** VoluMap provides a coded color map image in the myocardium based on the calibrated contrast intensity which estimates the myocardial volume. Our experience indicates that calibrated, parametric color image with iv. contrast has a great promise to identify ischemic seg correctly.

9:45 a.m.

805-5

**The Integrated Backscatter Signal is From Blood Within the Myocardium**

Antonio Micari, Marco Pascotto, Thanjavur Bragadeesh, Craig Norman Goodman, Sanjiv Kaul, University of Virginia, Charlottesville, VA

**Background:** It is generally thought that the myocardial integrated backscatter signal (IBS) is from myocardial elastic and other elements and that the IBS cyclic variation during the cardiac cycle is due to geometric alterations in these elements. We hypothesized that the signal is from the blood present within the myocardium-generally referred to as myocardial blood volume (MBV). It is well known that MBV undergoes phasic changes during the cardiac cycle.

**Methods and results:** To test our hypothesis, we altered MBV without altering myocardial contractility in 2 groups of dogs. In group 1 (n=7) we placed a non-critical stenosis (mean gradient 27±4) on the left anterior descending coronary artery (LAD). In group 2 (n=6), we performed a selective LAD infusion of intracoronary adenosine (5-7 µg/kg/min) that caused no systemic effects. Wall thickening remained unchanged in both groups before and after the intervention (32±0.6% vs. 33%±0.8, p=0.80 and 32.1±0.7% vs 31.9±0.6%, p=0.4). Resting IBS measurements and MBV estimated using myocardial contrast echocardiography (MCE) tracked each during the cardiac cycle. After stenosis placement, the end-diastolic IBS value increased without a change in the end-systolic value (-26.6±7.7 vs -25.1±6.8 p=0.01 and -30.3±7.46 vs. 30.0±7.7, p=0.50). The IBS cyclic variation increased (3.7±1.1 vs.5.0±1.0, p=0.02). The LAD flow increased 3-fold after adenosine infusion in the group 2 dogs. Again, the end-diastolic IBS value increased and the end-systolic value remained unchanged (-20.2±7.3 vs. -18.7±6.7, p=0.005 and -23.4±6.9 vs. -23.1±6.7, p=0.25). Cyclic change in IBS also increased significantly (3.47±1.1 vs. 4.37±1, p=0.04). The control left circumflex artery bed showed no change in IBS in either group of dogs.

**Conclusion:** In these experiments we increased MBV without changing myocardial contractility. We found that there was close tracking of cyclic changes in IBS and MBV. We also found that IBS values increased in diastole where MBV also is known to increase with the 2 interventions used. These results imply that the principal mechanism underlying IBS signal is MBV. These results also imply that non-critical stenosis could be detected at rest using IBS.

805-6

**Comparison of Real Time Perfusion Utilizing Continuous Infusions of Ultrasound Contrast During Vasodilator Stress With Radionuclide Uptake and Quantitative Angiography**

Feng Xie, Jeane M. Tsutsui, Anna McGrain, Edward L. O'Leary, Jordan Hankins, Heidi Mahrous, Thomas R. Porter, University of Nebraska Medical Center, Omaha, NE

**Background.** By examining both myocardial contrast replenishment (MCR) and plateau intensity (PI) within the capillary bed during vasodilator stress, intravenous continuous infusions of ultrasound contrast can visually quantify myocardial blood flow (MBF) changes using real time pulse sequence schemes (RTP). This may be more sensitive than myocardial blood volume techniques (radionuclide uptake) in detecting physiologically significant coronary stenoses (CAD).

**Methods.** In 36 patients with normal resting ejection fraction, a continuous infusion of 3 % Definity (Bristol Myers Squibb) was performed while imaging with RTP (Siemens Acuson or Philips Agilent). The vasodilator stress was adenosine in 18 and dipyridamole in 18. Both a delay in the rate of MCR following a brief high mechanical index impulse and a reduction in PI were examined, and compared with radionuclide uptake (SPECT) in all patients. Twelve (33%) subsequently underwent quantitative angiography (QCA). The agreement between techniques was measured on a coronary artery territory (CAT) basis.

**Results.** The Table demonstrates that of the 108 CATs analyzed, there were 22 abnormal by RTP, and 31 abnormal by SPECT. Agreement between SPECT and RTP was 86% (kappa=0.63). In the patients that underwent QCA, CAT agreement with SPECT was 75% (kappa=0.44), while agreement with RTP was 89% (kappa=0.72).

**Conclusions.** These data indicate that RTP using quantitative analyses of both MCR and PI may be superior to SPECT in detecting significant CAD.

Agreement between Three Imaging Techniques

Comparison	RTP vs SPECT	RTP vs QCA	SPECT vs QCA
Sensitivity	61%	89%	78%
Specificity	96%	89%	74%
Agreement	86%	89%	75%
Kappa	0.63	0.72	0.43

10:15 a.m.

805-7

**Reliable Analysis of Regional Left Ventricular Function: A Multicenter Study With Multimodality In-patient Comparison.**

Rainer Hoffmann, Stephan von Bardeleben, Adrian C Borges, Jaroslaw Kasprzak, Christian Firsche, Stephane Lafitte, Nidal Al-Saadi, Folkert ten Cate, Stefanie Kuntz-Hehner, Marc Engelhardt, Jean Louis Vanoverschelde, Harald Becher, University Aachen, Aachen, Germany

**Background:** Detection of regional wall motion abnormalities (RWMA) is an integral part in the evaluation of left ventricular function. This study evaluated interobserver for enhanced echo (UE), contrast enhanced echo (CE) and cineventriculography (Cine) and intermethod agreement to cardiac Magnetic Resonance Tomography (cMRT).

**Methods:** 120 pts with evenly distributed ejection fraction groups based on biplane Cine (>55%, 35-55%, <35%) UE and CE (Sonos 5500, [Philips], SonoVue infusion [Bracco, Milan]) were performed. 56 pts underwent additional cMRI at 1.5 T using a steady state free precession sequence. For UE, CE and cMRI, RWMA were assessed in 4CV, 2CV and 3CV projections referring to a 16 segment model (segM). CINE was evaluated on a standard 7 segM.. Hypokinesia in at least 1 seg defined presence of RWMA. Interobserver variability (IOV) between two independent readers (R) was determined within UE, CE and CINE for all patients. For the cMRT subgroup, intermethod agreement (IMA) between reader 1 of UE, CE and CINE and cMRT results was determined. To define a standard of truth for the presence of RWMA an independent expert-panel decision (EPD) was obtained for each patient based on clinical data, ECG, coronary angiography and blinded information from the imaging modalities.

**Results:** 77patients (64%) were found to have a RWMA by EPD. IOV between R1 and R2 within each UE, CE and CINE: Kappa was 0.51 (CI 0.34 - 0.69) for UE, 0.55 (CI 0.39-0.71) for CINE and 0.86 (CI 0.76-0.96) for CE.

IMA based on R1 between UE, CE and CINE compared to cMRI: Kappa was 0.35 for CINE, 0.63 for UE and 0.78 for CE.

Accuracy to detect RWMA related on the EPD: Sensitivity and specificity of reader 1 of each modality to detect RWMA was high for CE (94% and 99%, respectively) and cMRT (97% and 91%) and lower for UE (94% and 80%) and Cine (97% and 70%).

**Conclusion:** CE significantly improves IOV compared to UE and CINE and shows the closest agreement to cMRI in detection of RWMA. CE has also highest accuracy in the detection of RWMA defined by an independent EPD.

Noninvasive Imaging

ORAL CONTRIBUTIONS

**809 Advances in Single-Photon Emission Computed Tomography/Positron Emission Tomography for Risk Stratification**

Monday, March 07, 2005, 11:00 a.m.-12:15 p.m.  
Orange County Convention Center, Room 414A

11:00 a.m.

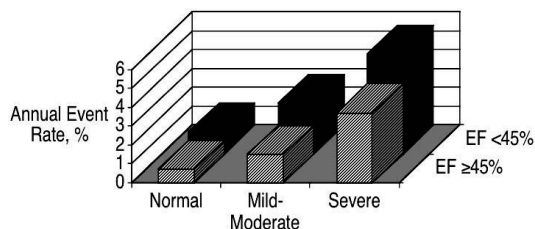
**809-3 Risk Stratification with Vasodilator Stress Gated SPECT Tc-99m Tetrofosmin Imaging: Results of a Multicenter Registry**

Robert C. Hendel, Jamshid Maddahi, Manuel D. Cerqueira, Naomi Alazraki, Salvatore Borges Neto, Leslee Shaw, Midwest Heart Foundation, Fox River Grove, IL

**Background:** Although substantial data exist regarding the utility of pharmacologic stress testing with thallium-201 and Tc-99m sestamibi in the prediction of cardiac events, limited data are available for adenosine and dipyridamole Tc-99m tetrofosmin SPECT imaging (TETRO). Furthermore, differences in tracer kinetics have raised questions regarding sensitivity and the ability of vasodilator TETRO to predict cardiac events.

**Methods:** Images were interpreted locally using a 20 segment, 5-point system and grouped by summed stress score: normal (0-3), mildly abnormal (abn; 4-8), moderately abn (9-13), and severely abn (>13). Time to cardiac events was calculated using a risk-adjusted Cox proportional hazards model.

**Results:** A total of 3,772 pts were enrolled in this 5 site study of dipyridamole (24%) and adenosine (76%) TETRO. A normal vasodilator TETRO had an annualized event rate for death and death/MI of 0.8% and 1.7%, respectively. An abn SPECT demonstrated increasing annual mortality, with mild, moderate, or severely abn summed stress scores, 2.8%, 3.4%, 7.3%, respectively. The risk-adjusted relative risk for events increased progressively for mild, moderately, or severely abn SPECT studies, 2.7, 3.1 and 4.4, respectively (p<0.0001). Incremental prognostic value was present when stratified by LVEF (Figure).



**Conclusions:** These results provide evidence for the prognostic value of TETRO in association with adenosine/dipyridamole and in a similar manner to SPECT data obtained with other tracers.

11:15 a.m.

**809-4 Normal Tc-Tetrofosmin Myocardial Perfusion SPECT studies in Asian Women Predict Good Cardiac Outcome**

Raymond Cc Wong, Kheng Thye Ho, National University Hospital, Singapore, Singapore

**Background:** The prognostic utility of normal Tc-99m tetrofosmin SPECT studies have been reported in Caucasians. It is unclear if the low event-rate is equally applicable to Asians, and to Asian women as to men. The issue of possible gender bias in referral onwards to angiography in Asian women with abnormal studies has also not been examined.

**Methods:** 6091 consecutive Asian patients underwent Tc-99m tetrofosmin stress studies at a single center in Singapore between 28<sup>th</sup> April 1999 and 30<sup>th</sup> April 2003. 4502 (74%) had normal stress studies defined as a score of 0-2 using a 20 segment/5 point visual scale. 1589 patients (26%) had abnormal studies. Uniform methods of data collection and standardized epidemiologic methods for follow-up were applied. Follow-up was complete with a duration of 24±5 months in 93% of patients.

The mean age was 61±12 years (females) and 57±12 years (males). 2641 (41%) were females. The racial distribution was 4215 (69%) Chinese, 784 (13%) Malay, 816 (13%) Indian, 276 (5%) others. 1761 (29%) had SPECT imaging for evaluation of chest pain and/or dyspnea.

**Results:** 1084 (18%) patients had diabetes mellitus, 2159 (35%) hypertension and 681 (11%) prior history of coronary disease. 2913 (48%) had exercise testing, while 3178 (52%) had pharmacologic stress. In all, 2236 (65%) males and 2266 (86%) females had normal studies.

At 24 months of follow-up, 0.8% of females with normal studies experienced myocardial infarction or cardiac death, yielding an annualized event rate of 0.4%. The figures for males were 0.9% and 0.45% respectively (p=0.4).

Of patients with abnormal studies, significantly less females (10%) than males (13%) underwent angiography within 3 months of the index study (p<0.01). This difference in angiography rates was maintained up to 2 years. However, multiple regression analysis controlling for age and diabetes did not reveal a significant gender bias.

**Conclusions:**

- 1) The negative predictive value of a normal Tc-99m tetrofosmin stress test was equally high in both Asian females and males.
- 2) Proportionately more males had abnormal SPECT studies.
- 3) There was no gender bias with regards to referral to angiography after abnormal SPECT studies in this large Asian cohort.

11:30 a.m.

**809-5 Positron Emission Tomography Myocardial Perfusion Imaging Abnormalities Predict Increased Mortality in Chronic Kidney Disease Patients**

Mark A. Stanekwicz, Amar D. Patel, Mikhael F. El-Chami, Steven R. Sigman, Arlene Chapman, Robert L. Eisner, Randolph E. Patterson, Carlyle Fraser Heart Center, Emory-Crawford Long Hospital, Atlanta, GA, Emory University School of Medicine, Atlanta, GA

**Background:** Coronary artery disease (CAD) is prevalent in patients with chronic kidney disease (CKD) and is responsible for the majority of morbidity and mortality in this population. Detection of CAD with myocardial perfusion imaging (MPI) single photon emission computed tomography (SPECT) is reported to be less accurate in patients with CKD. Rubidium-82 positron emission tomographic (PET) MPI is more accurate than SPECT, but its value to predict prognosis in CKD is unknown.

**Methods:** Demographic, clinical and PET results were recorded in all CKD patients who were evaluated with PET-MPI from 1999-2003. Mortality due to all causes was determined using the Social Security database and hospital records. Continuous variables were compared using the student t-test and categorical variables were compared with chi-squared (Yates) analysis (SPSS). Multiple regression analysis was used to identify independent predictors of mortality. A p-value of <0.05 was defined as statistically significant.

**Results:** 431 CKD patients with a mean creatinine of 7.44 mg/dL had PET-MPI during the 48 month study period. Over an average follow-up period of 24.2 months, the average mortality rate was 29%. There were 259 women (60%), 348 African-Americans (81%), and mean age was 60.2 years (29-91 years). Patients had the following risk factors: hypertension (89%), diabetes (49%), tobacco use (27%), hypercholesterolemia (40%) and family history of CAD (36%). Patients with abnormal versus normal PET-MPI were similar in age (61.8 vs 59.6 p=ns) and body mass index (27.7 vs 26.8, p=ns), but were more often diabetic (62% vs 42%, p<0.001). PET-MPI was abnormal in 34% of patients, and mortality was higher if PET-MPI was abnormal vs normal (46% vs. 28%, p<0.001). In a multivariable analysis, abnormal PET-MPI predicted higher all-cause mortality when controlled for age, race, hypertension, diabetes, creatinine, tobacco use and hypercholesterolemia (p=0.002).

**Conclusions:** Abnormal PET-MPI predicts increased mortality in patients with CKD, independent of other cardiovascular risk factors.

11:45 a.m.

**809-6 Myocardial Perfusion Imaging Risk Stratifies Women with Intermediate or High Duke Treadmill Score**

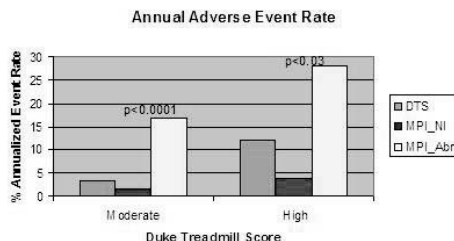
Justin B. Lundbye, Fawad A. Kazi, Scott Werden, Gavin L. Noble, Allison Whalen, Deborah Katten, Alan Ahlberg, David O'Sullivan, William E. Boden, Gary V. Heller, Hartford Hospital, Hartford, CT

**Background:** ACC/AHA guidelines recommend exercise tolerance test (ETT) in women with intermediate or high pretest probability for coronary artery disease (CAD). The purpose of this study was to determine whether SPECT myocardial perfusion imaging (MPI) further risk stratifies women beyond Duke Treadmill Score (DTS).

**Methods:** Women with intermediate or high pretest likelihood of CAD who underwent ETT Tc99 Sestamibi MPI (n=1,020) were categorized as low, moderate or high DTS. MPI was categorized as normal or abnormal. Mean follow-up was 2.38±1.49 years for all-cause mortality, revascularization (>60 days), and non-fatal myocardial infarction.

**Results:** Women with a moderate DTS (-10 to 4) had an overall annual event rate of 3.3%. Abnormal MPI identified patients at risk of adverse events within this group (1.8% vs. 16.8%; p<0.0001). Patients with a high DTS (<-11) had an overall annual event rate of 12.2%. Likewise, these patients could be further stratified based on MPI results (3.8% vs. 28.2%; p<0.03). (Chart) Adverse events were: revascularization (71.5%), non-cardiac death (13%), non-fatal MI (10.5%) and cardiac death (5%). Patients with low DTS had low event rate regardless of MPI (1.10%).

**Conclusion:** SPECT myocardial perfusion imaging reclassifies women with moderate or high Duke Treadmill Score to more accurately identify those at risk for adverse events. SPECT myocardial perfusion imaging should be performed in addition to ETT in women with intermediate to high pretest probability for CAD.





Noon

809-7

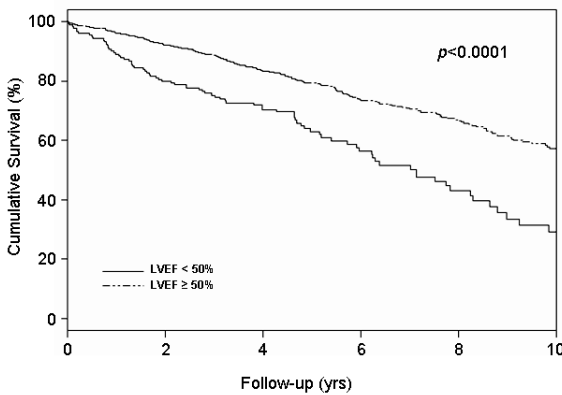
**Prevalence and Prognosis of Left Ventricular Systolic Dysfunction in Asymptomatic Diabetics Without Known Coronary Artery Disease**

Panithaya Chareonthaitawee, Paul Sorajja, Todd D. Miller, Navin Rajagopalan, David O. Hodge, Robert L. Frye, Raymond J. Gibbons, Mayo Clinic and Mayo Clinic College of Medicine, Rochester, MN

**Background:** The prevalence and prognosis of left ventricular (LV) systolic dysfunction in asymptomatic diabetic patients without known coronary artery disease (CAD) are not known.

**Methods:** From 1986 to 2000, 1046 diabetics (age 60±13 yrs, 69% male) without cardiovascular symptoms and with no known CAD underwent stress single photon emission computed tomography (SPECT) and assessment of LV systolic function (EF). SPECT images were classified as low, intermediate, or high risk based on the summed stress score (SSS). The mean follow-up was 5.3±3.3 yrs.

**Results:** The prevalence of LV systolic dysfunction (LVEF<50%) was 16.7% (n = 175; mean LVEF = 40.0±7.7%). This group was older (63±11 vs. 59±14 yrs; p = 0.005), had more peripheral arterial disease (45% vs. 29%; p<0.001), a higher proportion with ECG Q waves (21% vs. 9%; p<0.001), and more intermediate/high risk SSS (74% vs. 38%; p<0.001) than the group without dysfunction. Mean SSS (44.8±9.8 vs. 51.7±6.3; p<0.001), summed reversibility (4.7±5.0 vs. 2.9±4.5; p<0.001) and rest scores (49.4±7.2 vs. 54.6±3.1; p<0.001) were significantly more abnormal in the dysfunctional group. Survival was markedly impaired in patients with LV dysfunction (p<0.0001 vs. LVEF≥50%).



**Conclusion:** In this population of asymptomatic diabetics without known CAD referred for stress SPECT, LV systolic dysfunction was highly prevalent, occurring in 1 of 6 patients. The majority have intermediate/high risk SPECT scans. Survival of these patients is reduced with an annual mortality of 7%.

POSTER SESSION

**1109 Cardiovascular Ultrasound: Potpourri**

Monday, March 07, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 3:30 p.m.-4:30 p.m.

1109-87

**Quantitative Assessment of Pulmonary Hypertension in Rats by High-Frequency Echocardiography**

Ryoko Azakami, Fuminobu Ishikura, Kohei Okuda, Takashiro Hirano, Toshihiko Asanuma, Shintaro Beppu, Osaka University Graduate School of Medicine, Suita, Japan

**Background:** A pulmonary hypertensive (PH) rat model induced by monocrotaline (MCT) is commonly used at developing a new therapeutic method. However, there have been few studies to declare the efficacy of echocardiography to assess PH in small animals as rats.

**Purpose:** The aim of this study was to examine the accuracy of quantitative assessment of the echocardiographic findings of PH in rats.

**Method:** Fourteen rats were examined. MCT (5mg/kg) was injected into the subcutaneous in 7 rats (PH rats) for 15days. After 3 weeks, SONOS5500 (Philips) with high-frequency transducer (s12 probe) was applied. The right ventricular (RV) and left ventricular (LV) end-diastolic areas (EDA) were measured in the short axis view. Maximal flow velocity (Vmax), ejection time (ET) and acceleration time (AT) of the pulmonary artery flow were measured. The peak velocity of tricuspid regurgitant flow was measured to calculate the pressure gradient, which was compared with the direct measurement of the RV systolic pressure. Age-matched 7 normal rats were also examined as control.

**Results:** RV-EDA in the PH rats was significantly larger than that in the normal rats (0.23±0.07 vs. 0.06±0.02 cm<sup>2</sup>, p<0.05), while LV-EDA in the PH rats was significantly smaller than that in the normal rats (0.16±0.06 vs. 0.24±0.02 cm<sup>2</sup>, p<0.05). The Vmax and AT/ET in the PH rats were significantly smaller than those in the normal rats (Vmax: 65.2±11.6 vs. 86.5±8.6 cm/s, AT/ET: 0.19±0.05 vs. 0.37±0.07 p<0.05). The peak pressure gradient between RV and RA was 79.6±14.1mmHg in the PH rats. There was a good

correlation between Doppler and invasive methods (y = 0.84x + 5.5, r=0.94, p<0.0001).

**Conclusion:** High-frequency echocardiography is worthy for accurate quantitative evaluation of PH in rats. This method can be utilized at developing a new therapeutic method of PH.

1109-88

**Inflammation Is Correlated With Diastolic Dysfunction in Women**

William Merhi, Asma Aouthmany, Cristine Z. Dickinson, Irina Valk, Pamela Gray, Elaine Kish, Pamela M. Marcovitz, William Beaumont Hospital, Royal Oak, MI

**BACKGROUND:** Diastolic dysfunction (DD) is associated with myocardial stiffening, and is a major cause of CHF in women. Prior studies, mostly in men, show an association between DD, hypertension (HTN) and increased ventricular wall thickness (IVS). Recent reports suggest a role for obesity and insulin resistance in the pathogenesis of DD. Hypothesis: We postulate that inflammation as measured by hs-CRP and aortic sclerosis, may play a role in the pathogenesis of DD.

**METHODS:** We examined clinical and echo parameters in 449 patients (93% female, age 56±15) undergoing evaluation of suspected CAD. Echo parameters included ejection fraction (EF), IVS thickness (mm), aortic sclerosis (ASC) and E:E' (TDI) as a measure of diastolic function. DD was classified as normal if E:E'<8, and abnormal if E:E'≥8. Clinical variables (BMI, HTN, HgbA1C, and hs-CRP) were included.

**RESULTS:** Mean EF was .56±8 for the entire group. Age, hs-CRP, ASC, HTN, HgbA1C, BMI, and IVS thickness correlated in the univariate analysis with DD (see table). In a multivariate analysis, age (p<0.001), BMI (0.0006) and hs-CRP (p=0.016) remained predictive of DD.

	Age	CRP	BMI	IVS(mm)	HgbA1C	HTN	ASC
E:E'<8 N=193	48±15	2.5±2.3	27±6	9.3±17	5.6±.7	30%	28%
E:E'≥8 N=256	62±13	3.7±3.4	30±7	11±21	6.0±1	54%	68%
P	<0.0001	0.002	<0.0001	<0.0001	.0009	<.0001	<.0001

**CONCLUSION:** Markers of glucose intolerance ( BMI, HgbA1C) and inflammation (hs-CRP and aortic sclerosis) are associated with DD in this study. In a multivariate model, BMI , CRP and age remained as predictors. These findings suggest that inflammation plays a role in the pathogenesis of DD in women, likely through vascular dysfunction. Further studies are needed to clarify the mechanism.

1109-89

**Right Atrial Volume Is a Marker of Right Ventricular Systolic Dysfunction: An ADEPT Trial Substudy**

John A. Sallach, W. H. Wilson Tang, Tama Porter, Allen G. Borowski, Osmosalewa Lalude, Maureen Martin, Richard W. Troughton, Sanjeev Bhavnani, Allan L. Klein, Cleveland Clinic Foundation, Cleveland, OH, Saint Louis University, Saint Louis, MO

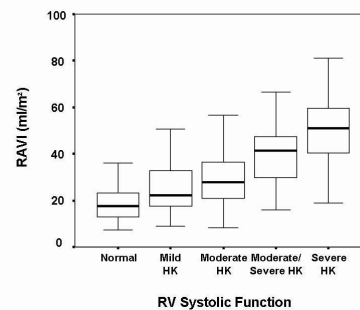
**Background:** Although left atrial volume is a known marker of left ventricular (LV) systolic dysfunction severity, similar associations between the right atrium (RA) and right ventricle (RV) have not been examined. We sought to determine the relationship between RA volume and RV systolic function.

**Methods:** The ADEPT (Assessment of Doppler Echocardiography for Prognosis and Therapy) Trial enrolled 183 patients (mean age 57 ± 14 yrs) with LV ejection fraction < 35%. On transthoracic echocardiogram, RA volume was calculated by Simpson's method and indexed to body surface area (RAVI). RV systolic function was graded as normal (30%), mild hypokinesis (HK) (24.5%), moderate HK (18.5%), moderate/severe HK (16%) and severe HK (11%). Echocardiographic variables were compared between these groups using ANOVA.

**Results:** Mean RAVI was 29 ± 17 ml/m<sup>2</sup> in the study population. RAVI was correlated positively with left atrial volume, LV end-diastolic volume, RV systolic function, and negatively with LV ejection fraction, hepatic vein S wave velocity and tricuspid annular tissue Doppler S' and A' velocities (all p < 0.001). As RV systolic dysfunction worsened, RAVI increased significantly (p<0.0001) (Figure 1). RAVI was strongly associated with severity of RV systolic dysfunction.

**Conclusions:** In patients with significantly depressed LV systolic function, RAVI expressed the severity of RV systolic dysfunction. This new echocardiographic marker can be used to identify patients with abnormal RV systolic function.

Figure 1. RAVI According to Severity of RV Systolic Dysfunction



1109-90

**Echocardiographic Outcome Predictors in Surgically Treated Patients with Infective Endocarditis**

Susan M. Sallach, Nick Dobrilovic, Brad Hirsch, Michelle Paul, Paul Pappas, Chris Cabell, JM DiMaio, Michael A. Wait, Gail E. Peterson, University of Texas Southwestern, Dallas, TX, Duke University, Durham, NC

**Background:** Despite use of echocardiography (echo) in the diagnosis of infective endocarditis (IE), few data exist identifying which features are associated with adverse outcomes in surgically treated patients. We sought to identify echo characteristics that predict hospital mortality in surgically treated patients with IE (and combined outcome of mortality, repeat valve surgery, recurrent IE and stroke).

**Methods:** Patients with surgically treated IE were retrospectively identified from 1991 to 2003. Data were entered into a standard case report form based on modified International Collaboration on Endocarditis and STS databases.

**Results:** We identified 197 consecutive patients with surgically treated IE; 95.9% met definite Duke Criteria. Average age was 45.6 years, 67% were men. Native and prosthetic valve IE occurred in 144 and 43 patients respectively. Echo findings included vegetation (75%), abscess (22.3%), valve perforation (13.7%), fistula (3%) and prosthetic valve dehiscence (6%). Location of vegetations were aortic (39.1%) mitral (36%), tricuspid (12%), pulmonary (4.1%) and nonvalvular (3.5%). Of these findings, abscess was the only one associated with increased mortality (25%,  $p < 0.01$ ) while valve perforation was associated with improved survival (0 deaths,  $p < 0.01$ ).

**Conclusions:** In a large group of patients with IE treated with surgery, the presence of abscess identified on echo predicted in-hospital mortality. The reasons for improved survival associated with valve perforation may involve the relative ease of surgical repair with this lesion, and warrants further investigation.

1109-91

**Characteristics of Echocardiographic Analysis in the Patients with Ischemic Mitral Regurgitation**

Tomoko Tani, Kazuaki Tanabe, Fumie Ono, Aki Kitamura, Minako Tani, Minako Katayama, Makoto Kinoshita, Koichi Tamita, Shuichiro Kaji, Atsushi Yamamuro, Kunihiro Nagai, Kenichi Shiratori, Shigefumi Morioka, Yukikatsu Okada, Kobe General Hospital, Kobe, Japan

**Backgrounds:** Ischemic mitral regurgitation (IMR) is usually associated with incomplete mitral leaflet closure defined as apically displaced coaptation with failure of the mitral leaflet to reach the level of the mitral annulus and without apparent intrinsic cusp abnormalities. Although undersized mitral ring annuloplasty is favorable in most cases of IMR, the degree of leaflet tethering may affect residual or recurrent mitral regurgitation after ring annuloplasty alone. Messas et al. proposed efficacy of chordal cutting to relieve chronic persistent IMR using sheep model. We performed ring annuloplasty alone or chordal cutting with a ring annuloplasty for severe IMR and assessed the efficacy by transthoracic echocardiography.

**Objectives:** We studied whether ischemic MR correlated with left ventricular (LV) ejection fraction (EF), LV end-diastolic dimension (Dd) and LV end-systolic dimension (Ds). And we investigated the characteristics of mitral valve movement.

**Methods:** We studied 36 patients with ischemic MR after myocardial infarction. 7 patients underwent chordal cutting associated with a ring annuloplasty (Group A). 29 pts underwent only ring annuloplasty (Group B). We excluded the patients with 1) aortic regurgitation 2) atrial fibrillation 3) apparent intrinsic cusp disease. Dd, Ds and tenting area were measured by two-dimensional echocardiography. EF was derived from apical two-and four-chamber views according to the modified Simpson rule. **Results:** In Group A, there were no changes after surgery (Dd;  $5.9 \pm 0.7$  cm vs  $5.5 \pm 0.9$  cm,  $p = 0.51$ ; Ds;  $5.1 \pm 1.0$  cm vs  $4.8 \pm 1.3$  cm,  $p = 0.63$ ; EF;  $34.2 \pm 10.0\%$  vs  $36.0 \pm 7.7\%$ ,  $p = 0.78$ ; pre vs post surgery). Tenting area was significantly decreased after surgery ( $2.5 \pm 0.4$  cm<sup>2</sup> vs  $0.5 \pm 0.1$  cm<sup>2</sup>,  $p < 0.0001$ ). In Group B, there were no changes of all modalities (Dd;  $5.6 \pm 1.0$  cm vs  $5.4 \pm 0.8$  cm,  $p = 0.67$ ; Ds;  $4.5 \pm 1.4$  cm vs  $4.4 \pm 0.9$  cm,  $p = 0.87$ ; EF;  $42.8 \pm 18.9\%$  vs  $39.9 \pm 11.7\%$ ,  $p = 0.63$ ; Tenting area;  $2.1 \pm 0.6$  cm<sup>2</sup> vs  $2.0 \pm 0.8$  cm<sup>2</sup>,  $p = 0.77$ ).

**Conclusions:** Chordal cutting associated with a small sized ring annuloplasty can effectively leaflet tethering. This procedure is thought to be an alternative to valve replacement for severe IMR.

1109-92

**Feasibility of Non-Contact Thrombolysis by High Intensity Focused Ultrasound Alone**

Kana Fujikura, Ryo Otsuka, Yukio Abe, Jeffrey A. Ketterling, Andrew Kalisz, Robert Muratore, Frederic L. Luzzi, Shunichi Homma, Columbia Presbyterian Medical Center, New York, NY, Riverside Research Institute, New York, NY

**Background:** Catheter-based invasive thrombolysis has been clinically evaluated as an efficient treatment of acute myocardial infarction. High intensity focused ultrasound (HIFU) may be a non-invasive alternative to dissolve a thrombus by externally focusing at the occlusive site. This technique may also be used in treating heparin contraindicated patients. Previous studies have indicated the feasibility of HIFU thrombolysis by using contrast agent and/or a thrombolytic agent. However, a method of thrombolysing by HIFU alone has not been well established. The purpose of this study was to evaluate the efficacy of HIFU-alone thrombolysis.

**Method:** Fresh blood was obtained from healthy males and placed in 1cc syringes. It was incubated at 37°C for 2 hours. The thrombi were removed from the syringes, separated by serum and cut in half ( $n = 44$ ) ( $194 \pm 18$  mg). The pair of thrombi were individually wrapped with polyethylene film, placed on the epicardial side of a block of calf left ventricle, and then placed in a phosphate buffer saline bath of 37°C. One thrombus was exposed to ultrasound; the other was not. An 80 mm diameter spherical-cap HIFU transducer with a 90 mm focal length was connected to an XY positioning device and was moved at a constant speed of 0.3 mm/s. The transducer was operated at a frequency of 510 kHz with a nominal intensity of 46 W/cm<sup>2</sup>. The HIFU was exposed for 240 s as a pulse wave (pulse repetition frequency = 2.0 ms; duty cycle = 1/40, 2/40, 3/40, 4/40). The *thrombolysis rate* was defined as the *fractional change of the thrombus mass* divided by the *fractional*

*change of the control mass*. The tissue damage underneath the thrombus was also visually examined.

**Result:** The thrombolysis rate was  $1.33 \pm 0.49$ ,  $1.73 \pm 0.39$ ,  $1.71 \pm 0.43$ ,  $1.61 \pm 0.14$  for duty cycles 1/40 ( $n = 5$ ), 2/40 ( $n = 5$ ), 3/40 ( $n = 6$ ), 4/40 ( $n = 6$ ) respectively. No damage was detected on the myocardium.

**Conclusion:** This study indicates that pulsed sinusoidal waves dissolve thrombi more efficiently than continuous waves. As the duty cycle increases, there appears to be a single point at which the pulse setting most efficiently dissolve the thrombus. Further study is required for evaluating the most efficient pulse setting to establish future clinical application.

1109-93

**Standard Anteroposterior Left Atrial Diameter Measurement Misclassifies Twenty Four Percent of Subjects with Regards to Atrial Dilatation Using Left Atrial Volume as the Gold Standard**

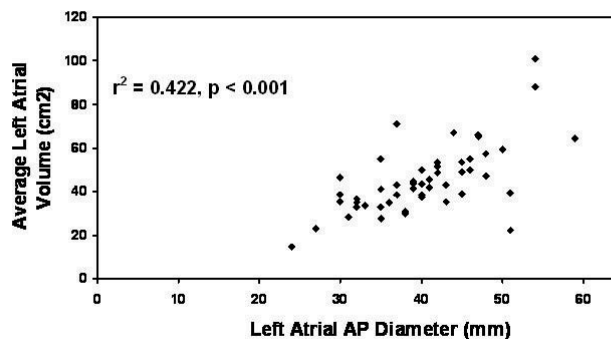
David A. Wood, Jessica Cochrane, Brad Munt, University Of British Columbia, Vancouver, BC, Canada, St. Paul's Hospital, Vancouver, BC, Canada

**Background:** Determining left atrial (LA) size is critical for managing both valvular and arrhythmic cardiac conditions. Currently, LA size is measured using the anteroposterior (AP) diameter in most echocardiographic laboratories. The purpose of this study was to compare standard LA AP diameter measurements with a more detailed LA volume measurement to determine their correlation.

**Methods:** Fifty consecutive patients with mild to severe mitral regurgitation and a native mitral valve had their LA AP diameter measured conventionally with two-dimensional transthoracic echocardiography. These patients then had their LA volume calculated as the average of the volumes by the method of discs in the two and four chamber apical views. This was taken as the gold standard.

**Results:** We found a statistically significant relationship between measured LA AP diameter and calculated LA volume ( $p < 0.001$ ); however, only 42 % of the LA volume information was contained in the AP diameter. We defined a dilated left atrium as  $> 95$  % predicted for age and gender from the Framingham database for AP diameter, and  $> 30$  ml/m<sup>2</sup>/BSA for volume. Only 37 patients (74 %) are correctly classified. Ten (20 %) patients are classified as dilated by AP diameter but have a normal volume, while 3 (6 %) of patients are classified as normal by AP diameter but have an increased volume.

**Conclusions:** Standard LA diameter measurements are statistically correlated with LA volume but 24 % of patients are misclassified if LA volume is used as the gold standard.



1109-94

**Assessment Of HIFU Lesion Size Using 2D Second Harmonic Imaging**

Kana Fujikura, Yukio Abe, Ryo Otsuka, Andrew Kalisz, Robert Muratore, Frederic L. Luzzi, Shunichi Homma, Columbia Presbyterian Medical Center, New York, NY, Riverside Research Institute, New York, NY

**Background:** High intensity focused ultrasound (HIFU) can ablate tissue without direct contact. We have demonstrated the ability of HIFU to create focal lesions in the myocardium, which may allow future non-invasive clinical ablation. In order to proceed toward the future clinical use of HIFU, it could prove useful to evaluate lesions immediately following HIFU exposure. HIFU lesions can be observed via 2D ultrasound imaging. The purpose of this study was to assess the utility of 2D second harmonic imaging in evaluating HIFU lesions.

**Method:** The left ventricular free walls of calf hearts were cut into cuboids approximately  $3 \times 6 \times 3$  cm, degassed and heated to 37°C in degassed phosphate buffered saline (PBS). A 5.25 MHz, 40 mm diameter, 35 mm focal length spherical-cap transducer was used. The spatial average intensity in the tissue was set to 15.5 kW/cm<sup>2</sup>. Lesions were created approximately 10 mm below the epicardial surface. A series of 0.2 s HIFU pulses was applied every 4 s, for 5 to 20 cycles, to create each lesion. Four lesions were created in each tissue sample by laterally moving the transducer between exposures. In addition, eight to nine lesions were created for each pulse setting. Acuson Sequoia Echo 256 (Siemens, Malvern, PA; second harmonic 1.75 MHz / 3.5 MHz) was used to capture the 2D ultrasound image. Ultrasonic 2D image was taken immediately before and after HIFU exposure; the lesion size was measured simultaneously. Then, the fresh (unstained) tissue specimens were cut and shaved carefully to show the maximum longitudinal cross-sectional lesion size and visually measured. These two measurement methods were compared.

**Result:** All 35 lesions were visibly detected. The lesion length had strong correlation between 2D and visual examination ( $y = 0.96x - 0.37$ ,  $r = 0.72$ ,  $p < 0.001$ ), whereas the lesion width had significant correlation between those two examination ( $y = 0.48x + 3.10$ ,  $r = 0.47$ ,  $p = 0.004$ ).

**Conclusion:** HIFU created well demarcated lesions inside the myocardial tissue. Both the length and the width of HIFU lesion were significantly well correlated between 2D and visual examination. This indicates the possibility of achieving the desired lesion sizes and locations in future clinical HIFU ablation.

POSTER SESSION

**1110 Novel Applications of Three-Dimensional Echocardiography**

Monday, March 07, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 3:30 p.m.-4:30 p.m.

**1110-79 Direct Measurement of Mitral Regurgitant Orifice Area by Transthoracic 3D-Doppler Echocardiography: Comparison With Conventional Methods**

**Katsuomi Iwakura,** Hiroshi Ito, Shigeo Kawanp, Atsunori Okamura, Toshiya Kurotobi, Motoo Date, Koichi Inoue, Yoshimune Hiramoto, Noriyuki Hanibuchi, Norihiro Hayashi, Takahiro Hashimoto, Hiroyuki Nagai, Masao Takeda, Kenshi Fujii, Sakurabashi Watanabe Hospital, Osaka, Japan

**Background:** Calculation of effective regurgitant orifice area (EROA) of mitral regurgitation (MR) with the proximal isovelocity surface area method (PISA) method has some technical limitations. We directly measured regurgitant orifice area with transthoracic 3D-Doppler echocardiography and compared its value to EROA by conventional methods.

**Methods:** We performed 3-D reconstruction of MR jet with Live-3D system on SONOS7500 (Philips Medical Systems) to measure EROA directly in 109 MR cases, and compared its value to that obtained by the PISA method. We also determined MR regurgitant volume by the quantitative 2D echocardiographic method, and divided it by time-velocity integral of MR jet to obtain EROA. To analyze the shape of regurgitant orifice, we calculated the ratio of long- to short-axis of the orifice (L/S ratio) on the cropped 3D images.

**Results:** EROA measured with 3D-Doppler method showed an almost identical correlation with that determined with the quantitative 2D-echo method ( $r=0.93$ ,  $p<.0001$ , slope:0.97) in spite of L/S ratio. The PISA method underestimated both EROA by the quantitative 2D-echo (slope: 0.65) and that by 3D-Doppler method (slope: 0.61) in the 62 cases with L/S ratio >1.5, but not in the cases with L/S ratio  $\leq$  1.5 (slope; 1.17 and 0.89, respectively). The Bland-Altman analysis revealed that there was a systemic bias in the cases with L/S ratio >1.5 between EROA by the PISA method and that by the quantitative 2D-echo method or that by 3D method. The good correlation between EROA by the 3D-Doppler method and that by the quantitative 2D-echo method was not affected by eccentricity of MR jet or by the presence of atrial fibrillation.

**Conclusion:** The direct measurement of EROA of MR with 3D-Doppler is a promising and quantitative method to overcome the limitation of the PISA method, especially in the cases with an elliptic orifice shape of EROA.

**1110-80 3D Geometry of Mitral Annulus in Mitral Valve Prolapse in Comparison with Normal: Real-time 3D Echocardiography study**

**Seong Mi Park,** Jung Chai, Min Jae Jeon, Chang Kun Lee, Dae Hyeok Kim, Keum Soo Park, Woo Hyung Lee, Jun Kwan, Inha University Hospital, Incheon, South Korea

**Background:** To elucidate the mitral annular geometry in mitral valve prolapse (MVP) in comparison with normal controls using a newly developed 3D computer program (TomTec).

**Methods:** Real-time 3D echocardiography (RT3DE) was performed in 10 MVP patients and 10 normal controls. 3D shape of the mitral annulus was reconstructed through 3D coordinates of annulus traced on 16 rotational apical planes during early and late systole. The mitral annulus was divided into anterior and posterior annulus by the line connecting 2 commissures. 3D surface areas of the anterior (aMAA), posterior (pMAA) and whole annulus (MAA) were automatically calculated. Non-planarity of annulus was estimated by non-planar angle (NPA) between 2 vectors from two hinge-points of the annulus in the antero-posterior plane to the center of the axis connecting two commissures in the commissure-commissure plane. All MAAs were corrected according to their height (cMAA).

**Results:** NPA and MAA were significantly larger in MVP patients than in controls in early and late systole. NPA and MAA were increased during late systole in all subjects (Table). **Conclusion:** RT3DE, with a newly developed program, demonstrated that the mitral annulus of MVP was significantly enlarged and flattened compared to normal controls.

Comparison of 3D Geometry of Mitral Annulus between Mitral Valve Prolapse and Normal

		NPA (°)	MAA(cm <sup>2</sup> )	cMAA (cm <sup>2</sup> /m)	pMAA/aMAA
Early systole	Control	142.3±4.3*	9.3±1.5	5.5±0.8*	1.7±0.3
	MVP	152.5±7.9*	10.5±1.6	6.6±0.8*	1.8±0.2
Late systole	Control	152.9±2.9* †	10.36±1.9	6.1±0.9* †	1.6±0.1*
	MVP	161.9±6.5* †	11.22±1.7	7.0±0.8* †	1.8±0.2*

\*p<0.05, control vs MVP, †P<0.05, Early systole vs Late systole in each group. NPA; non-planar angle, MVP; mitral valve prolapse, MAA; mitral annulus area, cMAA; corrected MAA by height, pMAA; posterior MAA, aMAA; anterior MAA.

1110-81

**Geometry of Mitral Apparatus in Functional Mitral Regurgitation: Real-time 3D Echocardiography Study**

**Jun Kwan,** Seong Mi Park, Min Jae Jeon, Chang Kun Lee, Dae Hyeok Kim, Keum Soo Park, Woo Hyung Lee, Inha University Hospital, Incheon, South Korea

**Aim:** To explore the geometry of the mitral apparatus including the degree of PM displacement in functional MR comparing with normal using RT3DE and 3D computer software and to seek the main geometrical determinant of the MR severity.

**Methods:** Twenty five patients with functional MR (ejection fraction:  $24 \pm 6\%$ , regurgitant orifice area:  $0.23 \pm 0.19$  cm<sup>2</sup>) and 12 normal controls underwent RT3DE. Antero-posterior (AP) and commissure-commissure (CC) dimensions of the mitral annulus, tethering angle of anterior ( $\alpha_a$ ) and posterior leaflet ( $\alpha_p$ ) and mitral valve tenting area (MVTa) were measured in two orthogonal apical planes with 3D computer software (4D Cardio-View, TomTec, Co.). The mitral annular area (MAA) was calculated from the equation of  $3.14 \times AP \times CC/4$ . For reliable estimation of the degree of papillary muscle (PM) displacement, we specified a head to measure among multi-heads of each anterior and posterior PM, which distributed chordae only to the anterior leaflet and located it using 3D computer software. Distances from the medial junction between aortic and mitral annulus (MJAM) to each head of 2 PMs were measured. Sum of these two dimensions ( $\Sigma$ MJAM-PM) was then calculated. Dimension between two heads (dPM) was also measured. All dimensions and areas were corrected (c) by the body surface area (BSA) of each patient.

**Results:** All corrected measurements were significantly larger in functional MR than normal ( $p < 0.01$ ). Among them, cMAA, cMVTa,  $\alpha_a$ , c $\Sigma$ MJAM-PM and cdPM showed significant correlations ( $p < 0.05$ ) with MR severity. As we explored the main determinants using multivariate stepwise linear regression analysis with those measurements showing significant correlations with MR severity, cMVTa was found to be the strongest determinant of MR severity ( $R^2 = 0.79$ ,  $p = 0.04$ ).

**Conclusions:** Among all geometric measurements of the mitral apparatus, corrected MV tenting area seems to be the strongest geometric factor determining the severity of functional MR. RT3DE with 3D computer software, providing accurate geometric measurements is a useful tool to elaborate the geometry of the mitral apparatus in functional MR.

1110-82

**Epicardial Mitral Annuloplasty in a Beating Heart for Mitral Regurgitation Secondary to Left Ventricular Dysfunction**

**Darshak H. Karia,** Davida Robinson, Kyung-Soon Hong, Alberto Milano, Kamal Khabbazz, Natesa Pandian, Tufts-New England Medical Center, Boston, MA

**Background:** Mitral regurgitation (MR) is a common complication of ischemic heart disease and an independent risk factor for death. Mechanisms include LV dilation and dysfunction, annular dilation and dysfunction, apical displacement of papillary muscles. Correction of MR favorably affects remodeling, heart failure and prognosis. Mitral annuloplasty (MAP) via open heart surgery ameliorates MR. However it needs cardiopulmonary bypass and has significant morbidity and mortality in presence of severe LV dysfunction. We explored epicardial MAP in a beating heart.

**Methods:** 8 sheep were anesthetized, intubated, and ventilated. Post-sternotomy, epicardial 2D echo with 5 MHz probe and 3D echo imaging using a xMatrix probe (Philips 7500 system) was performed. Marginal branches of left circumflex coronary artery (LCX) were occluded. Color Doppler verified MR. With the apex lifted, the AV groove was dissected, to avoid LCX or its branches. Multiple segment subcoronary plication sutures (GoreTex) were placed in the annular myocardium. 3D echo datasets were analyzed using Tomtec 4D Cardio-View™ RT software and measurements subjected to ANOVA with Bonferroni test. **Results:**

N=8	Baseline	Ischemia	Annuloplasty (MAP)	P value
MA Diastolic Area (cm <sup>2</sup> )	6.5±1.4	7.40±1.0	5.7±0.5¥	0.005
MA Systolic Area (cm <sup>2</sup> )	5.6±1.4	6.2±0.5	5.0±0.7¥	0.049
MA % Δ Area	13.6±6.4	15.7±6.6	11.5±5.8	0.26
MA Diastolic Circumference(cm)	9.4±1.1	10±0.6	9±0.4¥	0.017
MA Systolic Circumference (cm)	8.9±1.1	9.5±0.5	8.3±0.6¥	0.041
MA % Δ Circumference	5.79±5.1	5.19±2.9	7.2±3.9	0.66
MA Diastolic AP Diameter (cm)	2.3±0.4	2.6±0.5	2.1±0.2¥	0.021
MA Systolic AP Diameter (cm)	2.1±0.4	2.1±0.2	2.1±0.2	0.84
MA % Δ AP Diameter	9.1±5.8	17.8±10.1	1.1±8.5¥	0.001
MR (semi-quantitative)	0.88±0.35	1.81±0.59**	0.79±0.39	0.0005

MA= Mitral Annulus; %Δ=percent change (Dias V/s Sys); AP= anteroposterior; ¥ Ischemia v/s MAP; \*\* Baseline v/s MAP

**Conclusion:** Epicardial mitral annuloplasty in a beating heart model of ischemic mitral regurgitation is technically feasible and successful in significantly reducing mitral annulus area, circumference and regurgitation.

1110-83

**A Real-Time Three-Dimensional Digital Doppler Method for Measurement of Flow Volumes Through Mitral Valve and Aortic Valve in Children**

**Liping Bu,** Honghai Zhang, Michelle Disterhoft, Marika Klesic, Milan Sonka, Shuping Ge, Baylor College of Medicine, Houston, TX, University of Iowa, Iowa City, IA

One- or 2-dimensional echo Doppler methods for measurement of flow volumes have limited accuracy and clinical utility. A real-time 3-dimensional digital Doppler method (RT3DDD) that utilizes the 3D velocity profile is ideal for flow measurement.

**Methods:** A total of 20 subjects (11.2 ± 3.4 years, 10 male/10 female) were prospectively enrolled in this study. A Sonos 7500 ultrasound system (Philips, Andover, MA) with a X4 matrix transducer was used to acquire the RT3DDD data through mitral valve (MV) and aortic valve (AV). The left ventricular (LV) volumes were also obtained to determine

the stroke volume (SV) by real-time 3D (RT3DE) volumetric measurements (LVSV). The images were post-processed offline using dedicated software (TomTec 4D Echo-View 5.2) with two algorithms, i.e. the plane mode and sphere mode.

**Results:** There were no statistical difference between the two RT3DE algorithms. Measurements of MVSV and AOSV were compared with LVSV using Pearson tests and Bland-Altman analyses (Table 1).

Table 1. Pearson and Bland-Altman Analyses: RT3DE MVSV and AOSV compared with RT3DE LVSV

	r	Regression Equation	p Value	SEE (ml)	Mean Difference $\pm$ SD (ml)
MVSV	0.83	$y = 0.89x + 11.22$	<0.001	4.91	$6.8 \pm 4.9$
AOSV	0.71	$y = 0.57x + 26.09$	<0.001	5.41	$8.4 \pm 6.6$

**Conclusions:** It is feasible to acquire the 3D velocity profile through the mitral and aortic valve orifices by the RT3DE methods. The MVSV measured by this RT3DE method appears to correlate and agree better with the LVSV by the RT3DE than the AOSV. The RT3DE may become a useful clinical tool to measure flow volumes and quantify flow abnormalities in children with congenital and acquired heart diseases.

#### 1110-84 Real-time Three-Dimensional Echocardiography: A New Method for Assessing Left Atrial Size and Function

Sunil T. Mathew, Aasha S. Gopal, Rena S. Toole, William Schapiro, Nathaniel Reichel, St. Francis Hospital, Roslyn, NY, Stony Brook University, Stony Brook, NY

**Background:** 3D echo is a widely available method that permits accurate volumetric quantification. But, its use for obtaining reliable measures of left atrial (LA) volumes and function has not been established. We determined the number of image planes required to preserve adequate atrial sampling in normal subjects while limiting the effort devoted to boundary tracing and maintaining accuracy of results when compared to cardiac magnetic resonance imaging (CMR).

**Methods:** 46 normal subjects (age 21-76 yr, mean age 55 yr) were imaged by 3D echo (Philips) and by CMR. 3D echo volumes were obtained using 10 rotationally equidistant apical planes, manual boundary tracing and use of an approximating surface model (TomTec). Maximum LA volume was determined using 2, 4, 6, 8, and 10 planes. CMR volume was performed using contiguous, short axis, TrueFISP cine images.

**Results:** 3D echo using 10 planes versus CMR:  $r = 0.8$ ;  $SEE = 9$  ml;  $p < 0.0001$ ; RMS % error = 59 ml; Bias = -5.1 ml; Width of limits of agreement = 40 ml. Data from 2, 4, 6, and 8 planes were then compared to that from 10 imaging planes.

Comparison to 10-plane 3D echo

	Biplane 3D LA volume	4-plane 3D LA volume	6-plane 3D LA volume	8-plane 3D LA volume
r	0.79	0.9	0.92	0.96
SEE (ml)	10.8	7.7	6.2	4.6
p	<0.0001	<0.0001	<0.0001	<0.0001
RMS % Error	23	11	10	7
Bias (ml)	-12.6	-2.5	-3.2	-1.2
Width of Limits of Agreement	42	31	24	18

**Conclusions:** 1) Real-time 3D echo is validated as an accurate method to measure LA volume using CMR as a reference method. 2) Apical biplane 3D views considerably underestimate LA volumes in normal subjects. 3) Four equidistant image planes are sufficient to produce optimal results in normally shaped left atria with high correlation, low standard errors of the estimate and low systematic bias. Requirements for abnormal atria remain to be determined.

#### 1110-85 Three-Dimensional Echocardiography Is Useful in the Evaluation of Patients With Atrioventricular Septal Defects

Anthony M. Hlavacek, Karen Chessa, Andrew M. Atz, Scott M. Bradley, Fred A. Crawford, Girish S. Shirali, Medical University of South Carolina, Charleston, SC

**Background:** Recent advances in three-dimensional echocardiography (3DE) have enhanced its practicality. We assessed whether 3DE provided new information compared to 2DE among patients with atrioventricular septal defect (AVSD).

**Methods:** We retrospectively reviewed 3DE datasets in 52 studies on 51 patients (median age: 4.6 yrs, range 0-30 yrs; median BSA: 0.6 m<sup>2</sup>, range 0.2-1.9 m<sup>2</sup>) with any type of AVSD a 1-year period (4/03-4/04). 3DE findings were compared to 2DE and surgical reports. For each study, AVSD was classified by 2DE as one of the following: Unrepaired balanced defect, Repaired balanced defect with residual lesions, Repaired balanced defect without residual lesions, or Unbalanced defect. 3DE was graded as 1) Additive: 3DE resulted in a new finding or changed diagnosis, 2) Useful: While useful, 3DE did not result in new findings or changed diagnosis, or 3) Not useful.

**Results:** 3DE on unrepaired balanced AVSD and repaired AVSD with residual lesions was more often additive/useful (33/36; 92%) than on repaired AVSD without residual lesions or unbalanced AVSD (9/16 (56%),  $p = 0.009$ ). 3DE was additive or useful in all 3 patients with unbalanced AVSD being considered for biventricular repair. Images reviewed in the second half of the study period were more often additive (9/26; 35%) versus in the first half (4/26; 15%) ( $p = 0.2$ ). Useful information obtained by 3DE included: precise characterization of mitral regurgitation and cleft leaflet, substrate for subaortic stenosis, valve anatomy, and presence and location of additional septal defects.

**Conclusion:** 3DE provides useful and additive information in unrepaired balanced AVSD, repaired AVSD with residual lesions, and unbalanced AVSD where a two-ventricle repair was being considered. Proficiency in 3DE entails a learning curve.

1110-86

#### Usefulness of Real-Time Three-Dimensional Echocardiography for the Evaluation of Coronary Artery Morphology in Kawasaki Disease

Michio Miyashita, Nihon University, Tokyo, Japan

**Purpose:** Usefulness of recently developed real-time 3D echo was examined as to the evaluation of coronary artery morphology in Kawasaki disease.

**Subjects and Methods:** Hundred patients were used as subjects, ranging from 3 months to 13 years of age, who visited for Kawasaki disease follow-up. Coronary aneurysm was detected in four patients (one had a giant aneurysm), and coronary dilatation was found in five. Coronary artery visualization was evaluated and scored as one of four grades, zero to three points, for both 2D echo (2DE) and real-time 3D echo (3DE) performed using a Philips SONOS-7500. As for the evaluation criterion, visualization of each coronary artery was given zero points when not visualized, one point when partially visualized, two points when one or more segments, which were defined according to the AHA classification of coronary angiographic features, were visualized, and three points when two or more segments were visualized. Total scores in each patient and by coronary branches were compared between 2DE and 3DE.

**Results:** The total scores of coronary artery visualization were  $6.93 \pm 1.48$  and  $5.47 \pm 1.75$  points for 3DE and 2DE, respectively, showing a significantly higher score for 3DE than for 2DE ( $p < 0.01$ ). By coronary branches, the scores of right coronary artery visualization were  $2.39 \pm 0.58$  and  $2.05 \pm 0.84$  points for 3DE and 2DE, respectively; those of left anterior descending branch were  $2.49 \pm 0.63$  and  $2.30 \pm 0.74$  points for 3DE and 2DE, respectively; and those of circumflex branch were  $2.04 \pm 0.68$  and  $1.11 \pm 0.69$  points for 3DE and 2DE, respectively, showing a significantly higher score for 3DE than for 2DE in circumflex branch visualization ( $p < 0.01$ ). A mural thrombus could be delineated in the giant aneurysm.

**Conclusion:** 3DE was determined to be superior in coronary artery visualization to 2DE, particularly for the visualization of the right coronary artery and circumflex branches. 3DE is useful because this system can widely visualize coronary arteries running three-dimensionally. Since coronary arterial diameters can be measured three-dimensionally when an analytical software is used, this system is expected to improve the screening of coronary arteries and the throughput of the test.

#### POSTER SESSION

#### 1111 Cardiovascular Computed Tomography: Expanding Applications

Monday, March 07, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 3:30 p.m.-4:30 p.m.

1111-71

#### Multi-slice Computed Tomography versus Intracardiac Echocardiography to Evaluate Pulmonary Vein Anomaly Prior to Radiofrequency Catheter Ablation of Atrial Fibrillation: A Head-to-head Comparison

Monique RM Jongbloed, Jeroen J. Bax, Martijn S. Dirksen, Katja Zeppenfeld, Ernst E. van der Wall, Albert de Roos, Martin J. Schalij, Leiden University Medical Center, Leiden, The Netherlands

**Background:** Radiofrequency catheter ablation (RFCA) at the site of the pulmonary veins (PV) or their ostia is a potential curative treatment modality for atrial fibrillation. Different imaging techniques have been used to visualize the PV in order to guide RFCA. In the current study, a head-to-head comparison between multi-slice computed tomography (MSCT) and intracardiac echocardiography (ICE) was performed.

**Methods:** Forty-two patients (35 men, age  $49 \pm 9$  years) admitted for RFCA of PV ostia were studied. The pulmonary veins and their insertion in the left atrium were evaluated and measurements of PV ostia were performed in 2 directions (anterior-posterior (AP) and superior-inferior (SI)) with MSCT. 2-D measurements of PV ostia were performed with ICE prior to RFCA. Data obtained by MSCT and ICE were compared.

**Results:** Additional right PV were observed in 12 pts with MSCT and in 7 patients with ICE. One additional left PV was observed with MSCT, this vein was not noted by ICE. Common ostia of left PV were observed in 33(79%) with MSCT and in 31(74%) with ICE. Common ostia of right PV were observed in 13(31%) and 16(38%) patients respectively. Average ostial diameters measured with MSCT in AP directions were similar to 2-D measurements performed with ICE. In contrast, PV diameters measured by MSCT in SI direction were significantly larger than the 2-D ostial diameters measured with ICE. Indexes of AP- and SI diameters measured by MSCT were  $0.77 \pm 0.18$  and  $0.90 \pm 0.15$  for left and right PV respectively, indicating an oval shape especially left PV ostia.

**Conclusions:** Variation in PV anatomy is frequently observed with both MSCT and ICE. The sensitivity for detection of additional branches is higher for MSCT. 3-D imaging techniques, such as MSCT, are required to demonstrate an oval shape of PV ostia.

1111-72

#### Multi-Detector Computer Tomography in Evaluation of Arrhythmogenic Right Ventricular Dysplasia

Chandra S. Bomma, Kalpana Prakasa, Darshan Dalal, Harikrishana Tandri, Khurram Nasir, Crystal Tichnell, Cynthia James, Joao A.C. Lima, Elliot Fishman, Hugh Calkins, David Bluemke, Johns Hopkins University School of Medicine, Baltimore, MD

**Background:** Arrhythmogenic right ventricular dysplasia (ARVD) is characterized by right ventricular (RV) structural abnormalities and ventricular arrhythmias. The presence of RV abnormalities is one of the most important criteria for diagnosis of ARVD. Magnetic

resonance imaging (MRI) has been proposed as gold standard in the diagnosis of ARVD. However, many patients with suspected ARVD have implanted cardiac defibrillators (ICD's), which preclude MRI. The purpose of this study is to report our experience in employing multi-detector computer tomography (MDCT) to evaluate known or suspected ARVD.

**Methods:** The study population included 28 (17 males, 42±12yr) patients who were re-evaluated for ARVD at our institute. All patients had a comprehensive work up including MDCT. Prospective and retrospective gated, contrast enhanced CT images were acquired using 4-detector and 16-detector scanner in 17 and 11 patients respectively. Two patients had both MDCT and MRI. Images were analyzed for presence of findings consistent with ARVD. Ventricular volumes and inlet measurements and RV outflow tract (RVOT) area were measured. Ejection fraction was calculated when feasible.

**Results:** The images were free of artifact and interpretable in 24 patients. In 4 patients, motion artifacts severely degraded image quality and/or artifacts from ICD precluded detail interpretation. Of the 28 patients evaluated, 16 (57%) had a final diagnosis of ARVD based on the Task Force criteria. RV trabeculations is present in 16(100%) patients, RV free wall scalloping and RV intra-myocardial fat in 12(75%) and LV fat in 5(31%) patients. Increased RV volumes (224ml±50ml vs.168± 29ml; P=0.002), and RV inlet (52±11mm vs.42±7mm; P=0.01) were seen ARVD patients. Ventricular volumes and ejection fraction calculated from the MDCT data correlated very well with that from MRI in two patients.

**Conclusion:** The results of our study demonstrate that MDCT is useful to identify qualitative findings consistent with ARVD, and that it has a promising future in quantitative evaluation of RV volumes and function. ICD lead and motion artifacts occasionally interfere with the quality of MDCT images.

#### 1111-73 Coronary Stenosis Detection By 16-slice Computed Tomography In Heart Transplanted Patients : Comparison With Conventional Coronary Angiography And Impact On Clinical Management

Guido Romeo, Lucille Houyel, Jean François Paul, Philippe Brenot, Jean Yves Riou, Claude Yves Angel, Centre Chirurgical Marie Lannelongue, Le Plessis Robinson, France

**Background:** The aim of this study was to assess the efficiency of multi-slice computed tomography (MSCT) coronary angiography in the detection of significant focal stenosis (>50% in diameter) using 16-slice computed tomography in a population of heart transplanted patients.

**Methods:** Since April 2003, 53 consecutive heart transplanted patients (37 male, 13 female; mean post-transplantation time 7.6 ± 3.8, range 1 to 14.5 years; mean age at transplantation 40.6 ± 19 years) underwent 16-slice CT within 24 hours before or after their annual routine coronary angiography. Only angiographic segments >1.5 mm were considered for analysis.

**Results:** In all patients MSCT was carried out without complications. Three patients were excluded from the evaluation. Of 450 angiographic segments, 432 (96%) were judged evaluable by MSCT. Considering the segments suitable for analysis sensitivity was 80%, specificity 99%, positive predictive value 80%, negative predictive value 99%, and accuracy 99%. Of 50 patients, 44 (88%) were completely analyzed. In 20 of 44 (45%) patients with strictly normal MSCT, no stenosis were found at conventional coronary angiography. Considering the patients suitable for analysis, sensitivity, specificity, positive predictive value, negative predictive value, were 83%, 95%, 71%, and 95% respectively; accuracy was 93%.

**Conclusion:** Our study provides indications about the potential role of 16-slice Computed Tomography coronary angiography for non-invasive follow-up of patients with transplanted heart, suggesting that patients with a strictly normal MSCT at follow-up may avoid subsequent conventional coronary angiography. This strategy is currently applied in our institution.

#### 1111-74 Detection of Left Atrial Appendage Thrombus by Multi-slice Computed Tomography With Multiplanar Reconstruction in Atrial Fibrillation Patients

Hisashi Shimoyama, Kunihiko Hirose, Tamie Sato, Rie Futai, Masatake Hara, Masaru Morikawa, Nobuyoshi Tomioka, Yutaka Watanabe, Otsu Red Cross Hospital, Otsu, Japan

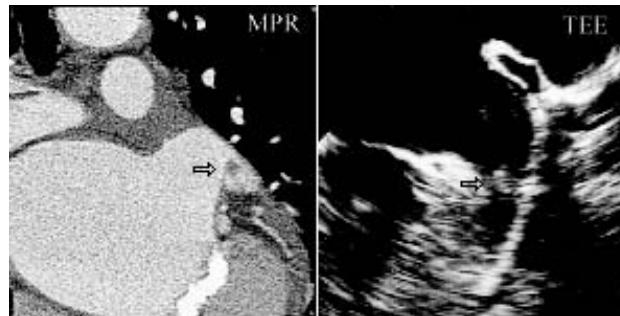
**Background:** Multi-slice computed tomography (MSCT), with a multi-detector system and thin slices enabling wide-range photographs to be taken using a short scanning time, may be a feasible and novel method for studying atrial fibrillation (AF) patients. We have compared MSCT with transesophageal echocardiography (TEE) for the detection of left atrial (LA) appendage thrombus in AF patients.

**Methods:** 20 AF patients (15 males, 5 females; mean age: 70 years old) were studied using MSCT and TEE. MSCT was performed using a 16 slice system (Toshiba Aquilion). The scan was performed with collimation of 0.5mm and gantry rotation of 400ms. Multi-Planar Reconstruction (MPR) images along the minor and major axes of the LA appendage were generated with a constant cardiac phase position immediately after the preceding T wave, defined by the absolute delay (ms) in order to avoid cardiac motion artifacts. The LA appendage thrombus was evaluated using axial images and MPR images.

**Results:** LA appendage thrombus was correctly detected by MSCT in 6 patients (sensitivity: 100%). In 12 patients, MSCT correctly predicted the absence of LA appendage thrombus, while in 2 patients, MSCT gave a false positive (specificity: 86%).

**Conclusion:** MSCT with axial MPR images has potential as an alternative to TEE for the detection of LA appendage thrombus in AF patients.

**Figure:** A small thrombus (arrow) is shown in an MSCT MPR image along the major axis of the LA appendage, and in a TEE view of the LA appendage using the longitudinal plane.



#### 1111-75 Planimetry Of Aortic Valve Area (ava) In Aortic Stenosis: Evaluation With 16-channel Multislice Computed Tomography (msct)

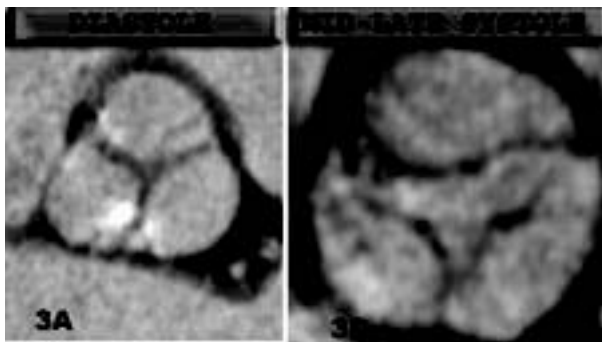
Guidrun M. Feuchtner, Wolfgang Dichtl, Silvana Mueller, Guy Friedrich, Mathias Frick, Hannes Alber, Dieter zur Nedden, Franz Weidinger, Otmar Pachinger, Innsbruck Medical University, Innsbruck, Austria

**Purpose:** Aortic valve area (AVA) is the key parameter to classify severity of aortic valve stenosis (AS). Purpose of this study was to evaluate whether 16-channel multislice computed tomography (MSCT) may provide a non-invasive imaging modality for planimetry of AVA in comparison to accepted diagnostic standard transthoracic echocardiography (TTE).

**Material and Methods:** 22 patients with asymptomatic, degenerative AS were examined prospectively with contrast enhanced MSCT (Somatom Sensation 16, Siemens, Germany) (16 x 0.75 mm; gantry rot.0.42 s, TF=6.7 mm/s; inc. 0.6; retrospective ECG-gating at mid-late systole) and TTE using continuity equation with doppler velocity time integral (VTI) for AVA calculation. Image quality was graded on a 5-point scale (1=excellent;5=non-diagnostic)

**Results:** MSCT planimetry of AVA (mean AVA 0.90 cm<sup>2</sup> +/-0.24) shows a good correlation to diagnostic standard TTE (r=0.86;r<sup>2</sup>= 0.73; p<0.001). Bland-Altman plot implies a good intermodality agreement with narrow limits of agreement (-0.18, 0.29) and a small bias (+0.05 cm<sup>2</sup>). Reproducibility as expressed by interobserver variability was good (4.6%). Image quality was 1(n=13);2 (n=6);3(n=3)

**Conclusion:** MSCT may provide a non-invasive, accurate imaging technique for planimetry of AVA in AS. MSCT may be implemented in clinical practice for simultaneous screening of asymptomatic AS in patients scheduled for coronary MSCT angiography and interchangeable for comprehensive diagnostic follow-up.



#### 1111-76 Comparison of Stress Thallium and Electron Beam Computed Tomography in Differentiating Etiology of Dilated vs. Ischemic Cardiomyopathy

Binu Jacob, M Leila Rasouli, Philip Tseng, Alex Chau, Matthew J. Budoff, Harbor-UCLA Research and Education Institute, Harbor-UCLA, CA

Stress echocardiography and nuclear imaging have both been utilized to differentiate between dilated and ischemic cardiomyopathy (CM). Electron Beam tomography (EBT) has recently been demonstrated to help a clinician distinguish between etiologies of CM. A noninvasive test that is accurate in differentiating the cause of CM could lead to cost savings and decreased morbidity in patients with congestive heart failure (CHF).

**Hypothesis:** To evaluate the diagnostic ability of nuclear stress testing and EBT to differentiate between nonischemic and ischemic CM, as compared to coronary angiography.

**Methods:** A total of 56 patients underwent technetium stress testing, EBT and coronary angiography for the evaluation of CM. Evidence of ischemia as the etiology for CHF was defined as >50% stenosis in at least one coronary artery by angiography. Evidence of ischemic CM by EBT was considered a calcium score >0. Evidence of ischemic heart disease as the etiology of CHF on technetium-stress was defined if either myocardial ischemia (reversible defect) or myocardial infarction (nonreversible defect) was present. Two by two contingency tables and Fisher's Exact Test were applied.

**Results:** Of the 56 patients, 34 (61%) had angiographically significant disease (ischemic cardiomyopathy). Using the criteria of either ischemia (reversible defect) or infarct (fixed defect), nuclear stress testing had sensitivity of 97% (33 of 34) but a specificity of only 14% (3 of 22). Using the criteria of only reversible ischemia present, specificity of nuclear stress testing improved to 50% (p<0.001), however sensitivity decreased to 56%. EBT score >0

had a sensitivity of 97% (33 of 34) and specificity of 68% (15/22) for defining ischemia. Using a cutoff of 100 to define positive EBT raised the specificity to 82%, but lowered the specificity to 82% (28 of 34). The mean calcium score by EBT for patients with ischemic CM was significantly greater than non-ischemic patients (753 vs. 108,  $p < 0.0001$ ).

This observational study shows that EBCT is an effective tool in assessment of ischemic vs. dilated CM. Given the high sensitivity, this test may prove to be an effective screen prior to angiography in patients with CHF of unclear etiology.

1111-77

#### Evaluation of Global Left Ventricular Myocardial Function Using Respectively ECG-Gated 16-Slice Multi-slice Spiral Computed Tomography: Comparison With Magnetic Resonance Imaging and Echocardiography

Christof Burgstahler, Martin Heuschmid, Torsten Beck, Axel Kuettner, Andreas F. Kopp, Stephen Schroeder, University of Tuebingen, Tuebingen, Germany

**Purpose:** To assess the quantitative measurement of left ventricular functional (LVF) parameters using retrospectively ECG-gated multi-slice spiral computed tomography (MSCT) and to compare the results with magnetic resonance imaging (MRI) and echocardiography.

**Materials and Methods:** 52 patients (pts) with suspected coronary artery disease were included in the present study. 16-slice MSCT scans (Sensation 16, Siemens) were performed using retrospective ECG-gating (0.75mm collimation, 2.8mm table feed/rotation, 0.42s rotation time). Based on the CT dataset, short axis reformations of the left ventricle with 8 mm slice thickness were performed for the functional analysis. On a commercially available workstation, end-diastolic volume (EDV), end-systolic volume (ESV) and stroke volume (SV) as well as ejection fraction (EF) were calculated from MSCT data according to the modified Simpson's method. In 24 pts, additional echocardiography was performed. The results from MSCT and echocardiography were compared with the functional analysis of MR imaging.

**Results:** In all cases, an adequate image quality of MSCT, echocardiography, and MR images was achieved. Comparing MSCT with MRI, the results for the determination of EDV, ESV, SV, and EF were as follows: EDV MSCT 140.6±40.0ml vs. MRI 125.5 ±29.4ml, Pearson  $r=0.83$ , [ $p < 0.0001$ ], mean difference (MD) 15.1±22.80; ESV MSCT 75.0±33.7ml vs. MRI 64.4±26.1ml,  $r=0.90$ , [ $p < 0.0001$ ], MD 10.6±15.5; SV MSCT 65.6±15.3ml vs. MRI 61.1±13.2ml,  $r=0.66$ , [ $p=0.008$ ], MD 4.5±11.9ml; EF MSCT 48.0±9.3% vs. MRI 49.6±9.6%,  $r=0.88$ , [ $p=0.0072$ ], MD -1.8%±4.7%. In comparison to MRI, the functional parameters determined by echocardiography were: EDV 89.5±41.6ml,  $r=0.05$ , [ $p=0.0012$ ], MD 36.2±48.0ml; ESV 70.7±39.3ml,  $r=-0.59$  [ $p=0.30$ ], MD 6.8±31.6ml, and EF 62.5±19.2%,  $r=0.24$ , [ $p=0.0018$ ], MD 13.9±19.2%.

**Conclusion:** Cardiac MSCT displayed a high correlation of LVF parameters compared to MRI. Thus, important additional information can be achieved. However, EDV, ESV and SV were overestimated and EF underestimated by MSCT. Compared to MRI, the echocardiographic results revealed a low or moderate correlation of functional parameters with significant overestimation of EDV and EF.

1111-78

#### Myocardial Perfusion and Wall Motion Abnormality in Adenosine 5-Triphosphate Provocation Multi-Slice Computed Tomography

Akira Kurata, Yasushi Koyama, Teruhito Mochizuki, Toyoko Haraikawa, Hiroshi Higashino, Shigeru Nakata, Jun Suzuki, Katsuji Inoue, Tomoaki Ohtsuka, Yuji Hara, Uji Shigematsu, Jitsuo Higaki, Ehime University, School of Medicine, Ehime, Japan

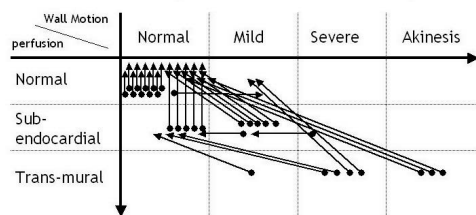
**Background:** Along with coronary artery imaging, contrast enhanced multi-slice CT (MSCT) can evaluate both wall motion and myocardial perfusion. We investigated whether adenosine 5-triphosphate (ATP) stress/non-stress MSCT with retrospective ECG-gating acquisition can evaluate both ATP induced ischemia and transient hypo-function in patients with coronary artery disease (CAD).

**Methods:** Ten patients with CAD underwent ATP stress MSCT, stress TI-201 myocardial perfusion scintigraphy (MPS). Dual-scan MSCT (ATP/non-ATP) was performed. First scan for the stress image was as follows; 70 ml of contrast medium was injected at a rate of 3 ml/sec during ATP infusion (0.16 mg/kg/min for 5 minutes). Twenty minutes after the first scan, nitroglycerin (0.6mg) was administered and the 2nd scan for rest image was done without ATP. Myocardial perfusion and wall motion were visually evaluated with animated MSCT movies and compared with TI-201 MPS.

**Results:** Perfusion MSCT grades in the 1st scan were correlated to MPS grades and wall motion grades. In deeper and lower density hypo-perfusion areas, wall motion and systolic thickening were worse. Hypo-perfusion areas during the 1st scan quickly turned normal in the 2nd scan in most cases. Hypo-perfusion/abnormal wall motion areas matched to significant coronary artery stenoses.

**Conclusion:** ATP stress/non-stress MSCT with retrospective ECG-gating acquisition can evaluate both ATP induced myocardial ischemia and hypo-function in patients with CAD.

Table. The Relation between myocardial perfusion and wall motion (before→after ATP infusion)



## 1112 Prognosis in Technical Advances

Monday, March 07, 2005, 1:30 p.m.-5:00 p.m.

Orange County Convention Center, Hall E1

Presentation Hour: 3:30 p.m.-4:30 p.m.

1112-63

#### Prognostic Value of Rest-Redistribution 201-Thallium Imaging in Patients With Chronic Coronary Artery Disease and Left Ventricular Dysfunction

Pasquale Perrone Filardi, Leonardo Pace, Santo Dellegrattaglia, Luigi Corrado, Maria Cafiero, Michele Polimeno, Roberta Camerino, Annamaria Zarrilli, Antonio Magliano, Massimo Chiariello, Institute of Cardiology, "Federico II" University, Naples, Italy, Institute of Nuclear Medicine, "Federico II" University, Italy

**Background:** The prognostic value of rest-redistribution thallium scintigraphy in predicting major cardiovascular events, in patients with ischemic left ventricular dysfunction, has not been extensively investigated.

**Methods:** One-hundred twenty-six patients with chronic coronary artery disease and mean left ventricular ejection fraction 39±11% were followed-up for 30±17 months after a rest-redistribution 201-Tl imaging single foton emission computer tomography (SPECT). Cardiac death and non-fatal myocardial infarction were considered as major cardiac events.

**Results:** A total of 20 events (11 deaths and 9 myocardial infarctions) were recorded during follow-up. By Cox multivariate analysis the number of severe irreversible SPECT defects was the only variable associated with outcome ( $\chi^2=5.06$ ,  $p=0.024$  for death + myocardial infarction; and  $\chi^2=10.6$ ,  $p < 0.001$  for death alone). By Kaplan-Meier analysis mortality was significantly different among patients with ≤3 (2%) severe defects as compared to patients with >3 severe defects (17%; log rank 8.68;  $p=0.0032$ ). Death or myocardial infarction occurred in 62% of patients with >3 severe defects compared to 13% of patients with ≤3 severe defects ( $\chi^2=18.04$ ;  $p < 0.0001$ ). Event-free survival was longer among patients with ≤3 severe defects than among patients with >3 severe defects (58±2 vs 16±3 months;  $p < 0.0001$ ).

**Conclusions:** The number of severe irreversible defects using rest-redistribution 201-Tl SPECT is a powerful predictor of major cardiac events among patients with moderate ischemic left ventricular dysfunction.

1112-64

#### Concomitant Anti-Ischemic Medication Does Not Affect the Prognostic Value of a Normal Stress Myocardial Perfusion Test

Antonio S. Ferreira, Antonio Ventosa, Victor Gil, Joao Calqueiro, Sonia Lima, Carlos Aguiar, Rute Couto, Luis Raposo, Ricardo Seabra Gomes, Hospital Santa Cruz, Carnaxide, Lisbon, Portugal

**Background:** Whether antianginal medication affects the prognostic value of a stress myocardial perfusion imaging test remains a controversial issue. Our hypothesis was that in patients with a normal single photon emission computed tomography (SPECT) stress test, outcome would be worse in those whose test was performed on anti-ischemic medication.

**Methods:** We retrospectively studied 352 consecutive patients with a normal stress myocardial perfusion SPECT. The study endpoint was time to a major cardiac event (cardiac death or non-fatal myocardial infarction).

**Results:** Previously documented coronary artery disease (CAD) was present in 79 patients (22.4%). Stress consisted of an exercise treadmill test in 233 tests (66.2%). At the time of testing, 71 patients (20.2%) were on beta-blocker therapy, 82 (23.3%) on calcium channel blockers, and 57 (16.2%) on nitrates. During a median follow-up of 4.8 years (range, 1.4 to 76.1 months), 12 patients (3.4%) suffered a major cardiac event (7 non-fatal myocardial infarctions and 5 cardiac deaths). Time to a major cardiac event was similar regardless of whether or not the test was performed under the effect of an anti-ischemic drug: event-free survival at last follow-up was 100% vs. 95.7% for beta-blockers, 93.9% vs. 97.4% for calcium channel blockers, and 94.6% vs. 96.9% for nitrates (log rank  $p$ -ns for all comparisons). Independently of the presence or absence of known CAD, performing the test under any anti-ischemic medication did not influence outcome, even after adjustment for other variables (age, gender, CAD risk factors, presence of left bundle branch block, and type of stress).

**Conclusion:** A normal stress SPECT performed under anti-ischemic medication remains a strong indicator of good prognosis.

1112-65

#### Temporal Progression of CAD in Patients with Previously Normal Rest/Stress Tc-99m Myocardial Perfusion Imaging: Diabetics vs. Non-Diabetics

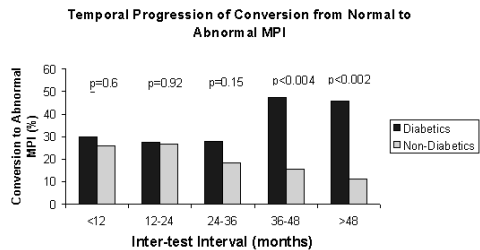
Gavin L. Noble, Christos Kasapis, Deb Katten, Ivette Leka, Sachin Navare, Alan Ahlberg, Gary Heller, Hartford Hospital, Hartford, CT, University of Connecticut, Farmington, CT

**Background:** The progression of coronary artery disease (CAD) following normal SPECT Myocardial Perfusion Imaging (MPI), particularly in diabetic patients, is incompletely understood. The purpose of this study was to evaluate serial testing in diabetic and non-diabetic populations for the identification of progression of CAD.

**Methods:** Patients with known or suspected CAD with initially normal MPI who underwent repeat clinically indicated MPI (Diabetics=192, Non-Diabetics=486) were evaluated. Repeat MPI studies were classified as normal or abnormal (fixed and reversible). Exclusions: intervening MI or revascularization.

**Results:** Overall, conversion to abnormal was significantly greater among diabetics (32.3% vs. 21.4%,  $p=0.003$ ). With inter-test intervals <2 years, conversion to abnormal MPI was similar between groups. However, at an inter-test interval of 2-3 years diabetics begin to separate, demonstrating significantly greater conversion to abnormal with inter-test intervals >3 years ( $p<0.004$ ). Mean inter-test interval was similar between diabetics and non-diabetics (796 vs. 789 days,  $p=0.87$ ).

**Conclusion:** Diabetic patients who underwent repeat, symptom-guided testing are at significantly higher risk for progressive CAD than non-diabetics. This risk increases over time, perhaps explaining higher cardiac event rates in diabetic patients despite previously normal MPI.



**1112-66 Prognostic Value of Exercise and Pharmacologic Stress Myocardial Perfusion Scintigraphy in Patients With Complete Left Bundle Branch Block**

Barbara Hesse, Hector M. Medina, Wael A. Jaber, Claire E. Pothier, Richard C. Brunken, Michael S. Lauer, Cleveland Clinic Foundation, Cleveland, OH

**Objectives:** To compare the prognostic value of pharmacologic versus exercise induced myocardial perfusion SPECT defects in patients with LBBB.

**Background:** In patients with LBBB, pharmacologic stress is recommended to improve diagnostic accuracy of myocardial perfusion SPECT. It remains unknown whether exercise affects the prognostic power of stress SPECT in this population.

**Methods:** 590 LBBB patients undergoing pharmacologic (N=283) or exercise (N=307) stress SPECT were followed for a mean of 5 years. Segments on SPECT were classified as septal/non-septal, and fixed/reversible, and the prognostic value of perfusion defects in these groups compared.

**Results:** 329 men and 261 women were included. There were 75 (27%) deaths in the pharmacologic and 73 (24%) deaths in the exercise group. On univariate analysis, non-septal defects predicted death in the exercise (fixed: HR 1.10, 95%CI 1.03-1.17,  $p=0.007$ ; reversible: HR 1.13, 95%CI 1.00-1.27,  $p=0.043$ ) and pharmacologic (fixed: HR 1.14, 95%CI 1.07-1.21,  $p<0.0001$ ; reversible: HR 1.13, 95%CI 1.03-1.24,  $p=0.011$ ) cohorts; septal defects were not predictive. After adjusting for confounders, non-septal defects remained predictive of death in the exercise (fixed: HR 1.10, 95%CI 1.03-1.18,  $p=0.005$ ; reversible: HR 1.13, 95%CI 1.00-1.27,  $p=0.05$ ) and pharmacologic group (fixed: HR 1.16, 95%CI 1.09-1.24,  $p<0.0001$ ; reversible: HR 1.11, 95%CI 1.01-1.21,  $p=0.029$ ).

**Conclusions:** In patients with LBBB undergoing stress SPECT, non-septal defects, but not septal defects, independently predicted death, regardless of the type of stress applied. Exercise did not adversely affect the prognostic power of perfusion defects, and may be a useful alternative to pharmacologic testing.

**1112-67 Prognostic Stratification of Elderly Patients Unable to Perform Exercise Tests Using Dobutamine Stress <sup>99m</sup>Tc-Tetrofosmin Myocardial Perfusion SPECT**

Arend F.I. Schinkel, Abdou Elhendy, Elena Biagini, Ron T. van Domburg, Roelf Valkema, Vittoria Rizzello, Chiara Pedone, Boudewijn J. Krenning, Maarten L. Simoons, Don Poldermans, Jeroen J. Bax, Thoraxcenter, Rotterdam, The Netherlands

**Background.** Information on prognostic value of noninvasive stress imaging techniques in the elderly is scarce. This study assesses the prognostic value of dobutamine stress <sup>99m</sup>Tc-tetrofosmin SPECT to predict of mortality and cardiac events in elderly patients.

**Methods:** Clinical information and SPECT results were analyzed in 272 consecutive patients  $\geq 65$  years of age (mean age  $71 \pm 5$  years, range 65-87 years) with limited exercise capacity. Follow-up was complete in 270 (99.3%) patients, 23 underwent revascularization within 60 days of the scintigraphy and were excluded. An abnormal study was defined as the presence of a fixed and/or reversible perfusion defect. A summed stress score (SSS) was obtained to estimate the extent and severity of perfusion defects. The incremental prognostic value of SPECT over clinical data was evaluated according to 3 multivariate models, which included respectively any SPECT abnormality, the presence of a fixed or reversible defect, and the SSS.

**Results:** During the  $3.3 \pm 1.4$  year follow-up, 59 patients died (29 cardiac deaths), 16 had a nonfatal infarction, and 24 underwent late revascularization. An abnormal scan was present in 140 (57%) patients. The annual event rates for total mortality, cardiac death, and cardiac death or nonfatal infarction were respectively 3.2%, 0.2% and 0.7% after a normal scan and respectively 9.5%, 4.3% and 8% after an abnormal scan (all  $P<0.0001$ ). Multivariate analysis showed that an abnormal scan, the presence of a fixed or reversible defect, and the SSS provided incremental prognostic information over clinical data. An abnormal scan was independently associated with an increased risk for total mortality, cardiac death, and cardiac death or nonfatal infarction (respectively hazard ratio 3.4 [95% CI 1.8-6.5], 12.1 [95% CI 2.9-51.5] and 9.0 [95% CI 2.8-29.6]).

**Conclusion:** Dobutamine stress <sup>99m</sup>Tc-tetrofosmin SPECT provides incremental prognostic information for the prediction of all cause mortality and hard cardiac events in the elderly. Elderly patients with a normal myocardial perfusion have a good prognosis, and do not require further invasive evaluation during the 3 years following the study, if no change in clinical status occurs.

**1112-68**

**Impact of Percutaneous Coronary Intervention in Patients With Myocardial Hibernation on Positron Emission Tomography Scans**

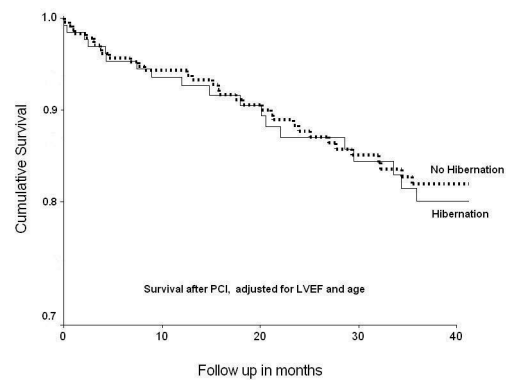
Hector M. Medina, Hitinder S. Gurm, Martin E. Lascano, Richard C. Brunken, Wael A. Jaber, Cleveland Clinic Foundation, Cleveland, OH

**Background:** Patients (pts) with myocardial hibernation (MH) have an increased mortality risk. While coronary artery bypass grafting has been shown to improve survival in this population, there is lack of data on the impact of percutaneous coronary intervention (PCI).

**Methods:** We analyzed the outcome of 407 pts undergoing Rubidium/Fluorine-18 Deoxyglucose Positron Emission Tomography (PET) scan followed by PCI within 1 year. Pts were characterized as having MH if they had 1 or more myocardial segments with FDG uptake with a corresponding mismatch in the Rubidium scan. Mortality data was obtained using the Social Security index. Mean follow up was 4 years.

**Results:** At least 1 segment with MH was noted in 103 pts. Pts with MH were significantly more likely to be diabetic (48% vs. 32%,  $p=0.004$ ), more likely to have a history of myocardial infarction (69% vs. 43%,  $p<0.001$ ), and had a lower left ventricular ejection fraction (32% vs. 48%,  $p<0.001$ ), compared to those without MH. Complete revascularization was achieved in 90% of the pts. There were 87 deaths on follow-up. There was no difference in mortality in pts with MH in unadjusted ( $p=0.082$ ) or adjusted analysis (fig) when compared to patients without MH.

**Conclusions:** In this series, pts with MH followed by PCI appear to have the same mortality risk of pts without MH, despite their higher likelihood of comorbidities and lower ejection fraction. Given the historical poor outcome in this group, PCI may be a viable revascularization option in carefully selected pts.



**1112-69**

**Effect of Body Mass Index on Attenuation-Corrected Single-Photon Emission Computed Tomography Imaging**

Neeraj Mehta, Scott Allison, Jaekyeong Heo, Ami E. Iskandrian, University of Alabama at Birmingham, Birmingham, AL

**Background:** Previous studies show that attenuation, scatter, and depth resolution correction (AC) improve the uniformity and diagnostic accuracy of single-photon emission computed tomography (SPECT) perfusion images. The effect of body mass index (BMI) on recovery of counts after AC and on non-uniformity is not well known and was investigated in this study.

**Methods:** We identified 120 patients (60 men and 60 women) who had normal stress gated SPECT perfusion imaging with Tc-99m-tracer. Patients with prior myocardial infarction, coronary revascularization, left bundle branch block, and non-sinus rhythm were excluded. The patients were divided into 3 groups based on BMI. Group I had BMI <25, group II, 25 to 30, and group III >30. The activity was counted in 9 segments per patient before and after AC. The percent increase was measured using the formula: (corrected - uncorrected) / uncorrected x 100. The uniformity was measured as percent difference between the highest and lowest segment counts both before and after AC.

**Results:** There was a 6 to 10 fold increase in counts after AC ( $p<0.0001$  in each group). The increase was  $6.9 \pm 1.0$  fold in group I,  $8.6 \pm 1.4$  fold in group II, and  $10.5 \pm 1.8$  fold in group III ( $p<0.0001$ ). The absolute counts after AC were less as BMI increased:  $7820 \pm 2690$  in group I,  $6660 \pm 2690$  in group II, and  $6260 \pm 2310$  in group III ( $p<0.01$  between group I vs. II or III). The uniformity was not related to BMI as the maximum difference decreased from 29% before to 17% after AC in group I, 28% to 18% in group II, and 27% to 20% in group III ( $p=ns$ ).

**Conclusion:** AC results in marked count recovery that is dependent on BMI but an improvement in uniformity that is independent of BMI.

**1112-70**

**Method for Detection of Serial Myocardial Perfusion SPECT Changes by 3D Volume-based Image Registration.**

Piotr Slomka, Hidetaka Nishina, Cigdem Akincioglu, Aiden Abidov, Daniel Berman, John Friedman, Guido Germano, Cedars-Sinai Medical Center, Los Angeles, CA

**Introduction:** Current techniques for detection of serial changes in myocardial perfusion SPECT (MPS) require separate comparisons to inter-subject normal limits which is not optimal due to potential mis-registration, multiple count normalizations and inter-subject variability. We propose a novel method for direct estimation of changes in serial MPS using image registration.



**Methods:** Paired serial stress scans from 166 patients (pts) forming 3 groups were considered: 1) scans of low-likelihood pts with normal perfusion (n=40) repeated within 2 years (NORMAL), 2) abnormal scans (n=29) repeated within < 1 month (REPRO), 3) scans repeated before and after revascularization (REVASC) (n=97). Iterative image registration utilizing 10-parameters (6 rigid body, 3 scaling, 1 normalization factor) was applied to serial scan pairs. Serial perfusion change (SPC) was defined as the ratio of counts remaining after normalized voxel count subtraction ( $100 \times (\text{study1} - \text{normalized study2}) / \text{study1}$ ) within common 3D ventricular boundaries. For comparison with standard approach, changes in myocardial perfusion were estimated by normal-limits based quantification (Q-%CH) and visual scoring (V-%CH). Positive change indicated improvement while negative change indicated worsening for Q-%CH, V-%CH and SPC. In addition, regional paired-subject variability of perfusion in low likelihood pts was compared to inter-subject variability in NORMAL group.

**Results:** In NORMAL group, average positive or negative SPC (1.8%) was lower than Q-%CH (2.9%) ( $p < 0.01$ ). In REPRO group, SPC was 1.7%, lower than Q-%CH (3.9%) and V-%CH (3.1%) ( $p < 0.01$ ). In REVASC group, the number of pts with positive SPC (>2.5%) was 75/97 compared with 67/97 identified by visual scoring ( $p = \text{NS}$ ) and 51/97 by standard quantification ( $p < 0.01$ ) (Q-%CH >2.5%). The serial count variability in NORMAL group for lateral/anterior/septal/inferior regions was 6.3%, 5.9%, 6.2%, and 5.4% respectively, lower than the inter-subject variability (8.2%, 9.3%, 9.4%, 7.8%).

**Conclusion:** The measurement of serial MPS perfusion changes by a 3D registration technique is feasible and is more reproducible than current quantitative or visual approaches.

known. These measured during dobutamine stress echocardiography (DSE) with tissue Doppler imaging (TDI) could assess this worsening in patients with heart failure (HF). 115 subjects with HF [47 LVSD/NQRS, 30 LVSD/WQRS, 38 preserved LV function (PVLV)] underwent DSE using a standard protocol in TDI mode after clinical and echocardiographic examination. Standard views at rest and peak stress, were analysed off-line. The time to peak systolic velocities from the onset of the QRS (Ts) were measured at 12 segments (6 basal, 6 mid) of LV. Each Ts were corrected for heart rate using the Bazett's formula ( $Ts_{cor}$ ). The standard deviation of the 12 Ts ( $Ts\text{-SD}$ ) and  $Ts_{cor}$  ( $Ts_{cor}\text{-SD}$ ) and the difference between the maximum and minimum Ts ( $Ts\text{-diff}$ ) and  $Ts_{cor}$  ( $Ts_{cor}\text{-diff}$ ) were computed as dyssynchrony indices. The paired *t* test was used to compare variables within the groups.  $P < 0.05$  was considered significant.

With stress  $Ts\text{-diff}$  do not change in both LVSD groups but decreases in PLVF group.  $Ts_{cor}\text{-diff}$ ,  $Ts\text{-SD}$  and  $Ts_{cor}\text{-SD}$  increases in both LVSD groups but not in PLVF group. The differences attain higher significance on rate correction.

Change in the dyssynchrony indices with stress.

	LVSD/NQRS/ Rest	LVSD/NQRS/ Peak Stress	p value	LVSD/WQRS/ Rest	LVSD/WQRS/ Peak Stress	p value	PVLV/All/ Rest	PVLV/All/ Peak Stress	p value
$Ts_{cor}$	213 (34)	224 (174)	0.71	242 (45)	300 (170)	0.09	204 (45)	118 (105)	<0.0001
$Ts\text{-SD}$	39.1(13.7)	66.1(48.0)	0.001	64.5(40.2)	86.9(45.0)	0.03	41.1(20.3)	35.8(28.4)	0.10
$Ts_{cor}\text{-diff}$	4.06(1.43)	10.28(8.07)	<0.00001	6.66(2.30)	13.65(7.37)	<0.00001	6.94(6.94)	5.43(4.93)	0.14
$Ts_{cor}\text{-SD}$	1.40(0.51)	3.04(2.25)	<0.00001	2.12(0.67)	3.94(1.98)	<0.0001	2.13(1.85)	1.64(1.35)	0.07

Intraventricular dyssynchrony worsens with stress irrespective of the resting QRS duration in HF patients with LVSD but not in PVLV.

2:30 p.m.

## ORAL CONTRIBUTIONS

### 815 Echocardiographic Assessment of Tissue Synchrony

Monday, March 07, 2005, 2:00 p.m.-3:30 p.m.  
Orange County Convention Center, Room 304E

2:00 p.m.

#### 815-3 Dyssynchrony Imaging, A New Method to Assess Left Ventricular Dyssynchrony Based on Myocardial Strain: Application to Dilated Cardiomyopathy

Takuya Hasegawa, Satoshi Nakatani, Hideaki Kanzaki, Kazuaki Wakami, Haruhiko Abe, Masakazu Yamagishi, Masafumi Kitakaze, Kunio Miyatake, National Cardiovascular Center, Suita, Osaka, Japan

**Background:** Although segmental differences in time to peak longitudinal myocardial velocities have been used to assess left ventricular (LV) dyssynchrony, they are sometimes affected by cardiac rotation and translation. A newly developed dyssynchrony imaging (DI, Toshiba), based on the angle-corrected tissue strain imaging, can color-code the difference in time to peak myocardial radial strain visualizing synchronous segments as green and dyssynchronous ones as yellow to red irrespective of cardiac rotation and translation.

**Methods:** We applied DI to basal and mid LV short-axis images in 18 patients with dilated cardiomyopathy (DCM, 8 with narrow, 10 with wide QRS) and 8 normals. The time to peak myocardial strain from QRS complex were measured in the anteroseptal, anterior, anterolateral, posterolateral inferior, inferoseptal segments at base and mid LV and the maximal time difference between any 2 segments was obtained (DTmax).

**Results:** By DI, LV showed homogeneously green to yellow in normals but regionally red in DCM. DTmax was significantly longer in DCM than normals ( $147 \pm 43$ ,  $306 \pm 132$ ,  $316 \pm 115$  ms for normals, DCM with narrow QRS, with wide QRS,  $p < 0.01$  for normals vs. DCM). DTmax  $\geq 200$  ms predicted dyssynchrony in 62% of DCM assessed by the traditional method based on longitudinal velocities.

**Conclusions:** DI demonstrated differences in timing of peak myocardial radial strain. The discrepancy between DI and the traditional method may reflect the effect of cardiac rotation and translation on the latter.



2:15 p.m.

#### 815-4 Does Intra-ventricular Dyssynchrony Worsen With Stress In Patients With Left Ventricular Systolic Dysfunction?

Sudipta Chattopadhyay, M. F. Alamgir, N. P. Nikitin, A. L. Clark, J. G. Cleland, University of Hull, Kingston upon Hull, United Kingdom

Intraventricular dyssynchrony is prevalent in patients with ischaemic left ventricular systolic dysfunction (LVSD) with normal (NQRS) and increased QRS (WQRS) duration. Whether the indices of dyssynchrony increase with stress as ischaemia worsens is not

#### 815-5 Evaluation of Left Ventricular Asynchrony Using Echocardiographic Phase Imaging in Patients with Heart Failure undergoing Cardiac Resynchronization Therapy.

Helmut Kuecherer, Arthur Filusch, Stefan Hardt, Alexander Bauer, Alexander Hansen, Grigorios Korosoglou, Lei Sui, Helene Houle, Pat von Behren, Nelson B. Schiller, Hugo A. Katus, University of Heidelberg, Heidelberg, Germany, Siemens Medical Solutions, Mountain View, CA

**Background:** Mechanical asynchrony relates to clinical outcome in patients with heart failure. Contraction asynchrony is usually evaluated using tissue doppler imaging (TDI) to measure timing of longitudinal myocardial contraction velocities. Automated objective methods visualizing temporal sequence of cyclic endocardial motion are lacking. We tested whether parametric echocardiographic phase imaging (EPI, Siemens) of endocardial motion can be used to objectively quantify intraventricular contraction delays.

**Methods:** Time to peak myocardial velocity was measured using pulsed-wave TDI in 12 patients (mean age  $63 \pm 7$  years) with dilated (n=2) or ischemic (n=10) cardiomyopathy (EF  $28 \pm 4\%$ ) and implanted biventricular pacemakers. Asynchrony was determined as the difference between the electromechanical coupling times in the basal lateral and septal segments with pacing modes set to achieve maximal delays between LV and RV activation. Digital cine-loops of apical four chamber views were mathematically transformed using a first harmonic Fourier algorithm displaying magnitude and temporal sequence of cyclic endocardial motion in a color-coded format. Atrial phase was used as a reference to define end-diastole (phase angle  $0^\circ$ ). Regional phase angles were converted to time units with  $360^\circ$  comprising a full R to R interval. Contraction delays derived from TDI were compared to those derived from EPI using linear regression and Bland-Altman statistics.

**Results:** Motion asynchrony was easily identified from parametric images. Lateral to septal contraction delays ranged from  $-220$ ms to 400ms. EPI correlated very closely with TDI ( $r = 0.998$ ,  $p < 0.0001$ ,  $SEE = 0.013$  ms). The mean difference between TDI and EPI derived contraction delays was  $3.2 \pm 13.6$  ms with upper and lower limits of agreement of 29.7 and  $-23.4$  ms. Phase measurements were highly reproducible with an interobserver variability of  $3.1 \pm 25$  ms.

**Conclusion:** Echocardiographic phase imaging allows automated objective visualization and quantification of intraventricular asynchrony in patients with biventricular pacemakers. This method supports the analysis of the effects of resynchronization therapy on left ventricular function.

3:15 p.m.

#### 815-6 Why Do Patients with Non-Ischemic Dilated Cardiomyopathy Respond Better to Biventricular Pacing Than Those with Ischemic Cardiomyopathy?

Tasneem Z. Naqvi, Ahmed Khan, Asim Rafique, Charles Swerdlow, Nancy Taubenfeld, Linda Arnold, Mary Vigil, Walter Kerwin, C. Thomas Peter, Cedars Sinai Medical Center, Los Angeles, CA

**Background:** Pts with non ischemic (NI) cardiomyopathy (CM) respond better to Biventricular (Biv) pacing than those with ischemic (I) CM. Biv pacing causes cardiac resynchronization and shortens isovolumic contraction time IVCT. We hypothesized that, for a comparable degree of LV dysfunction, pts with NICM have more dyssynchrony than those with ICM. **Methods:** We evaluated 52 pts with ICM and 30 pts with NICM with pulsed wave Tissue Doppler Imaging (TDI, GE Vivid 7 system). Dyssynchrony was evaluated by conventional M-mode method and at 12 basal and mid-myocardial segments by pulsed wave TDI using off line Echo Pac workstation. **Results:** There was no difference in LVEF ( $0.32 \pm 0.1$  vs.  $0.31 \pm 0.1$ ), age, NYHA class, heart rate, LV end diastolic dimension or volume, or mitral regurgitation severity in ICM vs. NICM pts. IVCT was more prolonged ( $100 \pm 32$  vs  $61 \pm 33$  ms,  $p < 0.001$ , and systolic ejection time was shorter ( $245 \pm 47$  vs  $284 \pm 47$ ,

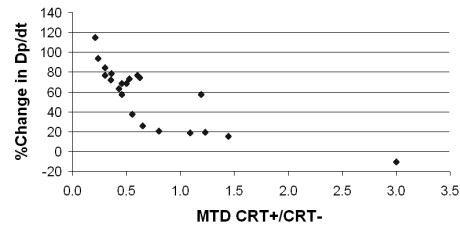


p<0.01) in NICM vs ICM pts. The table shows dyssynchrony parameters in ms. Data are Mean±SD, λ, p<0.001, γ p<0.03. Conclusion: For a given degree of LV dysfunction, pts with NICM have more dyssynchrony and longer IVCT than pts with ICM. This may explain their greater response to CRT than pts with ICM.

Dyssynchrony Parameters in Patients with ICM and NICM

	QRS Duration	Septoposterior Wall Delay (M-mode)	Standard Deviation of Time to Peak Contraction (TDI)	Standard Deviation of Time to Peak Systolic Displacement (TDI)
ICM	142±40	157±66	34±14	62±21
NICM	157±66	165±96 <sub>γ</sub>	42±16 <sub>γ</sub>	87±33 <sub>λ</sub>

3:00 p.m.



815-7

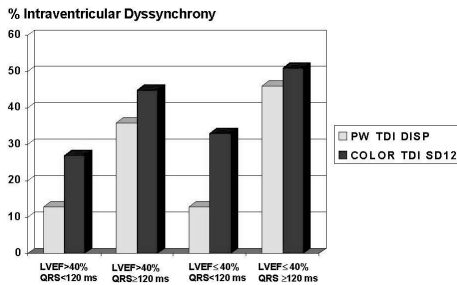
Evaluation of Intraventricular Dyssynchrony in Heart Failure Patients: a Direct Comparison between Pulsed Wave and Color Tissue Doppler Imaging

Johan De Sutter, Nico R. Van de Veire, Guy Van Camp, Patrizio Lancellotti, Pieter Vandervoort, Luc Muyldermans, Tine De Backer, Philippe Unger, University Hospital, Ghent, Belgium, Belgian Working Group on Echocardiography and Cardiac Doppler

**Aim:** To compare Color tissue Doppler imaging (TDI) & Pulsed wave TDI parameters for the assessment of intraventricular mechanical dyssynchrony (IVMD) in heart failure (HF) patients.

**Methods:** We studied 85 HF pts (age 66±12 yrs, LVEF 34±14%, NYHA class 2.35±0.8, QRS 141±44 ms), referred for evaluation of IVMD. According to Penicka et al, PW TDI was used to calculate the time to onset of systolic movement in 4 basal LV segments (sept, lat, ant & inf). Dispersion (= longest-shortest time interval, DISP) ≥60ms was defined as significant IVMD. According to Yu et al, color TDI was used to calculate the time to peak systolic movement in 6 basal and 6 mid segments (sept, lat, ant, inf, post and anterosept). A standard deviation (SD) ≥35 ms was defined as significant IVMD.

**Results:** Inter and intraobserver variability was <10% for DISP & SD (p=ns). The global prevalence of IVMD was 32% using DISP & 42% using SD (p=ns). Both DISP & SD correlated with LVEF (r=-0.35, p<0.01 and r=-0.31, p<0.01) & QRS duration (r=0.48, p<0.01 & r=0.38, p<0.01). Prevalence of IVMD increased from 13% to 46% for DISP (p<0.05) & from 27% to 51% for SD (p<0.05) in pts with a QRS40% compared to pts with a QRS≥120ms & LVEF≤40% (fig). Prevalences of IVMD tended to be lower in pts with small QRS using DISP compared to SD.



**Conclusion:** IVMD can be reliably assessed by both PW & Color TDI in HF pts with an increase of IVMD with decreasing LVEF & increasing QRS duration. About 50% of pts with HF, LVEF≤40% & QRS≥120ms show significant IVD using PW or Color TDI.

3:30 p.m.

815-8

Acute Synchrony Changes During Cardiac Resynchronization Therapy Predicts Acute Hemodynamic Response

Cynthia C. Taub, Dali Fan, Jagmeet Singh, Theofanie Mela, Michael H. Picard, Massachusetts General Hospital, Boston, MA

**BACKGROUND:** Cardiac resynchronization therapy (CRT) improves myocardial performance in many patients. Early identification of these patients is challenging. The aim of this study was to determine if echocardiographic (echo) parameters of improved LV synchrony with CRT could predict acute hemodynamic response.

**METHODS:** One hundred consecutive patients with heart failure meeting indications for CRT were studied shortly after device implantation. Echoes were performed with and without CRT (CRT+, CRT-). Indices of LV function were measured including LVEF (biplane Simpson's), wall motion score, Tei index, +dP/dt and -dP/dt (from mitral regurgitation Doppler (MR)). LV synchrony was quantified by the Maximum Time Difference (MTD) to peak systolic velocity between septal, inferior, anterior and lateral walls as measured by tissue Doppler.

**RESULTS:** In fifty-six patients, MR was sufficient to calculate +dP/dt. The magnitude of acute changes in +dP/dt with CRT was not related to baseline LVEF, wall motion score or size of LV scar (%akinesis). However, the degree of dyssynchrony as measured by the MTD with CRT off was related to the increase in +dP/dt (r<sup>2</sup>=0.28, p=0.01). Moreover, a strong inverse relationship existed between the percent increase of +dP/dt and improvement in synchrony with CRT as expressed by the ratio of MTD with CRT on to CRT off (see graph, r<sup>2</sup>=-0.63, p<0.001).

**CONCLUSION:** The acute change in LV synchrony measured by tissue Doppler can be used to identify hemodynamic improvement early after CRT.

ORAL CONTRIBUTIONS

821FO

Featured Oral Session... Cardiovascular Magnetic Resonance Imaging: Emerging Clinical Trials and Outcome Data

Monday, March 07, 2005, 4:00 p.m.-5:30 p.m. Orange County Convention Center, Hall F1

4:15 p.m.

821-4

Abdominal Aortic Plaque by Magnetic Resonance Imaging Is Seen More Frequently Than Coronary Artery Calcium in Young Women in the Dallas Heart Study

Hao S. Lo, Roderick McColl, Greg Stanek, DuWayne Willett, Ronald M. Peshock, University of Texas Southwestern Medical Center, Dallas, TX, Donald W Reynolds Cardiovascular Clinical Research Center, Dallas, TX

**Background:** Abdominal aortic plaque (AAP) by magnetic resonance imaging and coronary artery calcium (CAC) are two methods for detection of atherosclerosis. AAP was compared to CAC in the Dallas Heart Study (DHS), a population-based, multi-ethnic cohort. We tested the hypothesis that individuals with AAP differ from those with CAC. **Methods:** AAP was compared to CAC in 2514 DHS participants. Images of the abdominal aorta at 1.5T were obtained using a gated, T2 weighted, black blood sequence. AAP positive (AAP+) was defined as either areas of hyper-intense signal or luminal protrusion. Electron beam computed tomography CAC score ≥ 10 Agatston units was considered positive (CAC+).

**Results:** 912 individuals (40.3%) were AAP+, 466 (20.6%) were CAC+, and 1190 (52.6%) were negative for both. Using univariate analysis, the AAP+/CAC- group was associated with female sex, younger age, lower body mass index, less hypertension and less diabetes:

Comparison of Groups

Variable	AAP+/CAC-	AAP-/CAC+	p value
Age (years)	46.0	51.1	<0.01
Sex (% female)	57.1	36.3	<0.01
Body Mass Index (kg/m <sup>2</sup> )	29.2	31.1	<0.01
Hypertension (%)	34.5	51.0	<0.01
Diabetes (%)	10.2	20.0	<0.01
Ethnicity (% black)	57.9	61.9	0.40
Total Cholesterol (mg/dl)	183.3	183.1	0.96

Using a multivariate logistic regression model, correcting for classic cardiovascular variables, the AAP+/CAC- group was associated with female sex, young age, positive family history of myocardial infarction, low body mass index and low high-density lipoprotein levels.

**Conclusions:** In the DHS, AAP is present in younger women and may be a better detector of atherosclerosis than CAC in this population. Thus, these differences should be considered when applying atherosclerosis detection techniques in future population-based and intervention studies.

4:30 p.m.

821-5

Efficacy of Gadoversetamide Enhanced MRI for the Diagnosis and Assessment of Myocardial Infarction: An International, Multicenter, Double-Masked, Randomized, Phase 2 Trial

Raymond J. Kim, Timothy SE Albert, James H. Wible, Jr., Michael D. Elliott, John C. Allen, Jr., Jennifer C. Lee, Alicia Napoli, Robert M. Judd, Duke Cardiovascular Magnetic Resonance Center, Durham, NC, Tyco Healthcare / Mallinckrodt, St. Louis, MO

**BACKGROUND** The diagnosis and assessment of myocardial infarction (MI) is important for therapeutic and prognostic purposes. We prospectively tested the efficacy of gadoversetamide enhanced MRI in patients (pts) with first MI.

**METHODS** Pts were enrolled in an ACUTE arm (≤16 d post MI), CHRONIC arm (17 d - 6 mo), or both; then randomized to 1 of 4 doses of masked gadoversetamide: 0.05, 0.1, 0.2, or 0.3 mmol/kg. Standard delayed enhancement MRI was performed precontrast (control), and 10 and 30 mins postcontrast. For masked analysis, pre- and postcontrast MRIs

were separated, randomized, then scored for hyperenhanced regions by 3 independent readers not associated with the study. The infarct-related-artery (IRA) perfusion territory was scored from the masked x-ray angios at a separate core lab.

**RESULTS** 514 pts (54±11 yrs, 76% M) had 566 scans performed in 22 centers using commercially available scanners from all major vendors. None of the scans were removed from the analysis because of image quality. The MI detection rate was markedly higher (p<0.0001) postcontrast (e.g. 99% ACUTE; 95% CHRONIC at 0.3 dose) than precontrast (<17%, TABLE). When MI was identified postcontrast, the readers detected the MI in the correct location (matched to IRA) in 94-100% of cases. Peak CKMB and Troponin levels correlated significantly with infarct size determined by MRI for doses above 0.05 mmol/kg (p<0.001).

**CONCLUSION** Gadoversetamide enhanced MRI is highly effective in the diagnosis and assessment of MI independent of infarct age.

Sensitivity (%) of Gadoversetamide for the Detection of MI

Dose (mmol/kg)	PreContrast (%)	PostContrast 10 min (%)	PostContrast 30 min (%)
<b>ACUTE, n=282</b>			
<b>0.05</b>	14.4	50.7	47.3
<b>0.1</b>	13.2	89.3	85.3
<b>0.2</b>	16.9	95.6	93.0
<b>0.3</b>	13.7	99.1	99.6
<b>CHRONIC, n=284</b>			
<b>0.05</b>	6.2	53.2	44.8
<b>0.1</b>	3.2	83.8	73.0
<b>0.2</b>	8.1	88.7	86.3
<b>0.3</b>	9.8	95.2	93.5

4:45 p.m.

**821-6 Cardiac MRI: Infarct Size is an Independent Predictor of Mortality in Patients With Coronary Artery Disease**

David Bello, Rishi Kaushal, David Fieno, Michael Radin, Emanuel Shaoulain, Jagat Narula, Jeffrey Goldberger, Alan Kadish, Kalnayam Shivkumar, University of California at Irvine, Irvine, CA, Northwestern University, Chicago, IL

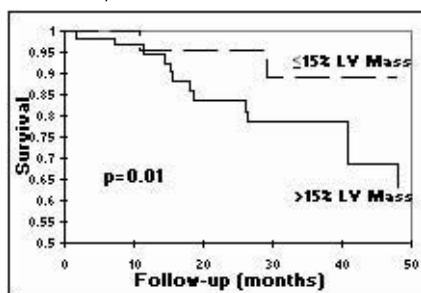
**Background:** Cardiac magnetic resonance imaging (CMRI) can accurately determine infarct size. Prior studies using indirect methods to assess infarct size have shown that patients with larger myocardial infarctions (MI) have a worse prognosis than those with a smaller MI. This study assessed the prognostic significance of infarct size by CMRI.

**Methods:** Cine and contrast MRI were performed in patients with coronary artery disease (CAD) undergoing routine cardiac evaluation.

**Results:** 100 patients (mean age 66±11 years, 87% male, 23% with diabetes, 49% with hypertension, 62% with prior MI, mean ejection fraction (EF) 34±13%) underwent CMRI. Mean follow-up was 25±18 months after MRI, during which time 15 patients died. Cox regression was used to estimate risk of death associated with traditional risk factors, heart failure symptoms, EF, angiographic severity of CAD, and extent of infarct size. Evidence of MI based on CMRI was present in 91% of patients. The only two significant univariate predictors of death (all-cause) were evidence of infarction greater than 15% of left ventricular (LV) mass and extent of LV dysfunction based on EF (p<0.05). On multivariate analysis, presence of MI >15% of LV mass was the single best independent predictor of death (p=0.01) with an adjusted relative risk of 9.9 (95% CI 1.6-63), figure 1.

**Conclusions:** The extent of MI determined by CMRI is an independent predictor of death in patients with CAD.

Figure 1: Survival curve for patients with infarct mass ≤15% and >15% of LV mass



5:00 p.m.

**821-7 Prognostic Value of Delayed Contrast-enhanced Cardiovascular Magnetic Resonance in Patients with Reperfused Acute Myocardial Infarction**

Matthias Regenfus, Christian Schlundt, Carolin Stingl, Johannes von Erffa, Robert Krähner, Michaela Schmidt, Janice Hegewald, Werner Adler, Birgit Pucher, Werner G. Daniel, FAU Erlangen-Nürnberg, Erlangen, Germany

**Background:** Delayed contrast-enhanced cardiovascular magnetic resonance (DE-CMR) can be used to assess myocardial viability, its value for assessment of prognosis after reperfusion acute myocardial infarction (MI) is not known. We investigated whether DE-CMR is able to determine cardiac prognosis in patients with reperfusion acute MI.

**Methods:** 102 patients (pts) with left ventricular (LV) dysfunction (EF 42±8%) were examined on a 1.5T scanner within 6±3 (4-10) days of a reperfusion acute MI. Cine and DE-CMR (10 min after injection of 0.15 mmol/kg Gd-DTPA) was acquired and scored for regional wall thickening and contrast enhancement (HE) using a 17-segment model.

Segments were considered to be viable if showing < 25% HE. LV ejection fraction (EF) was determined by planimetry. Serial clinical follow-up was obtained in all patients (mean follow-up 2.5±1.3 years) regarding occurrence of cardiac death, death attributable to any cause, myocardial infarction, myocardial revascularization, and unstable angina or congestive heart failure requiring hospitalization. Patient-related and CMR data were analyzed in a multivariate Cox regression model.

**Results:** Among the 102 patients, there were 11 cardiac deaths and reinfarctions in the follow-up period, additionally there were 26 patients with myocardial revascularization or hospitalization due to unstable angina or congestive heart failure. Patients with events at follow-up showed significantly lower EF (45.3±12.7 vs. 37.7±14.3, p = 0.006) than patients without events. In patients with cardiac deaths or reinfarction, the dysfunctional area by CMR (0.65 vs. 0.48, p = 0.08) and the dysfunctional but viable area by CMR (0.16 vs. 0.27, p = 0.008) was significantly higher than in patients without such events. By multivariate analysis EF (hazard ratio 0.98, CI 0.95 to 1.0, p = 0.03) and the dysfunctional but viable area by CMR (hazard ratio 1.4, CI 0.9 to 3.0, p = 0.04) were related to occurrence of future events independent of the presence of risk factors for coronary atherosclerosis.

**Conclusions:** In patients after reperfused acute MI, DE-CMR can be used to forecast major adverse cardiac events.

5:15 p.m.

**821-8 Detection of Right Ventricular Infarction by Cardiac Magnetic Resonance Imaging**

David Ian Paterson, Alex Natanzon, Breno Pessanha, Andrew E. Arai, National Institutes of Health, Bethesda, MD

**Background:** Right ventricular (RV) involvement in acute inferior wall myocardial infarction (IMI) is difficult to diagnose with conventional techniques. However, clinically detected RV infarction has been shown to be associated with worse prognosis.

**Hypothesis:** We hypothesized that cardiac MRI (CMR) will detect clinically unsuspected right ventricular involvement in patients with acute IMI.

**Methods:** 45 consecutive patients (36 male, mean age 60) with first-time acute IMI underwent CMR in a community hospital. Imaging consisted of steady state free precession cine MRI (FIESTA) and contrast-enhanced inversion-recovery fast gradient-recalled echo for infarct detection. Left and right ventricular volumes, ejection fractions (EF) and regional wall motion abnormalities were specifically evaluated. Readers blinded to the CMR results performed chart reviews on all patients. Outcomes measured included in-hospital mortality and length of stay.

**Results:** Right ventricular involvement was detected by CMR (RV+/CMR) in 10 of 45 patients with acute IMI but was only clinically suspected in 2 (p=0.01). RV delayed enhancement was present in 8 and RV wall motion abnormalities in an additional 2. 9 of these 10 patients underwent echocardiography however an RV abnormality was revealed in only 1 case. Older age (p=0.03) and diabetes (p=0.054) were more common in the RV+/CMR group than the RV-/CMR group. Mean blood pressure at presentation, peak cardiac enzyme rise and the presence of ST elevation were similar in both groups. At cardiac catheterization, the prevalence of significant stenoses of the proximal or mid right coronary artery as well as the rate of angioplasty and stent deployment were also similar between RV+/CMR and RV-/CMR patients. CMR revealed similar LVEF, left ventricular volume and right ventricular volume but RVEF was significantly decreased in the RV+/CMR group (52% vs. 60%, p < 0.001). Length of stay was similar in both groups, 2.6 days vs. 3 days, and all patients survived to discharge.

**Conclusions:** RV involvement associated with acute IMI was detected 5 times more often by CMR than was clinically suspected. However, outcome in these subclinical RV infarcts does not appear worse.

ORAL CONTRIBUTIONS

**823 Doppler Myocardial Imaging: Here to Stay**

Monday, March 07, 2005, 4:00 p.m.-5:30 p.m.  
Orange County Convention Center, Room 304E

4:00 p.m.

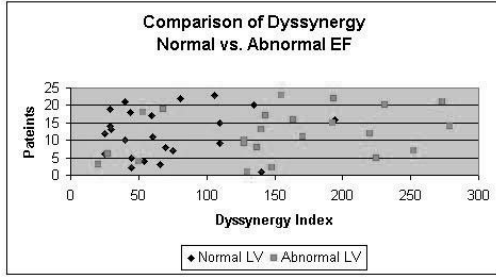
**823-3 Validation of a Novel Echocardiographic Method to Assess Dyssynchrony**

Rebecca Andrews, Leo Polosajian, Eman Hamad, Anita Kelsey, Karoly Kazala, Ellison Berns, Neal Lippman, Joseph Dell'Orfano, Richard Soucier, Saint Francis Medical Center, Hartford, CT

**Background:** Cardiac resynchronization is a therapy for treating CHF in patients with dyssynchrony. QRS duration is the standard marker of dyssynchrony. A significant proportion of patients with conduction delay do not respond to this therapy. For this reason, other markers of dyssynchrony have been proposed. We propose a simple, reproducible tissue Doppler measurement (TDIm) of mitral annular motion to evaluate ventricular dyssynchrony (VD). In normal hearts, the time to peak mitral annular velocity (TMV) should be uniform across the annulus and patients with dyssynchrony should demonstrate non-uniform movement. We sought to validate this measurement in patients with reduced ejection fraction (EF).

**Methods:** 46 patients referred for trans-thoracic echocardiography underwent TDI of 4 separate points of the mitral annulus to assess VD. 23 pts had normal EF and 23 had EF < 40%. We defined a "dyssynergy index" (DI) representing the variation in (TMV) at 4 separate points.

**Results:** TDI are shown below. Using a novel method of analysis, there is a significant difference in VD in pts with normal, mean DI 44 +/- 9, vs. abnormal EF, mean 74 +/- 15, (p value<0.001).



**Conclusions:** Our findings demonstrate a significant difference in the DI in normal patients vs. patients with reduced EF. This method of VD measurement is simple, reproducible, and obtained with standard echo measurements. This may improve patient selection for biventricular pacing in patients with LV dysfunction and warrants further study.

4:15 p.m.

823-4

**Improvement of Left Ventricular Dyssynchrony by Carvedilol Therapy in Patients with Idiopathic Dilated Cardiomyopathy: Analysis using Strain Echocardiography**

Yasuhiro Takemoto, Takeshi Hozumi, Kenichi Sugioka, Yoshiki Matsumura, Yasuhiro Takagi, Keiji Ujino, Takashi Muro, Minoru Yoshiyama, Junichi Yoshikawa, Osaka City University School of Medicine, Osaka, Japan

**Background:** Many studies have reported beneficial effects of cardiac resynchronization therapy using biventricular pacing in patients (pts) with idiopathic dilated cardiomyopathy (IDC) and dyssynchronous wall motion abnormality. While carvedilol has been reported to be favorable in these pts, precise mechanisms of its beneficial effects are still undefined. Strain echocardiography (SE) accurately depicts myocardial mechanical activity and can be used to interrogate segmental ventricular systolic function. The purpose of this study was to evaluate the effects of carvedilol on segmental left ventricular (LV) systolic function and dyssynchrony using SE in pts with IDC.

**Methods:** SE (GE Vivid 7) was performed in 12 pts with IDC before, 1 month and 6 months after administration of carvedilol. Regional myocardial contraction was evaluated by measuring both value of peak systolic strain (S peak) and time from ECG R to peak systolic strain corrected by square root(RR) (T peak) at mid and basal segments of all 6 LV walls. The coefficient of variation (CV) of both S peak and T peak was calculated as an index of dyssynchrony of LV contraction.

**Results:** Table shows the results obtained from SE before, 1 month and 6 months after administration of carvedilol (# p < 0.05 vs. Before).

**Conclusion:** SE analyses showed that not only abolishing the intersegmental differences in duration of systole but also restoration of mechanical segmental synchrony was crucial for recovery of global LV systolic function by carvedilol therapy.

	Before	1 month	6 months
EF (%)	29 ± 7	31 ± 7	38 ± 11#
T peak	13.6 ± 1.4	12.5 ± 1.2#	12.4 ± 1.5#
CV of T peak (%)	18 ± 5	15 ± 6#	14 ± 6#
S peak	-8.4 ± 1.6	-11.1 ± 4.4#	-12.4 ± 3.4#
CV of S peak (%)	44 ± 9	50 ± 24	34 ± 17#

4:30 p.m.

823-5

**A New Rapid and Simple Index of Mechanical Dyssynchrony by Color-Coded Strain Dyssynchrony Imaging**

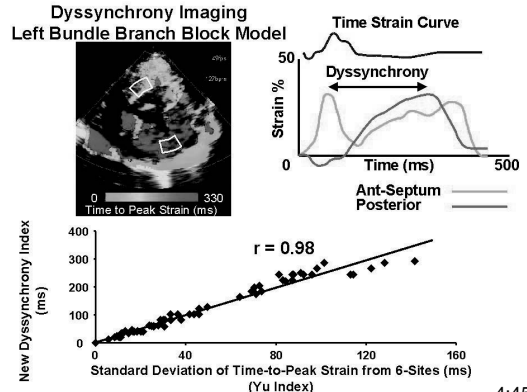
Kaoru Dohi, Michael R. Pinsky, Matthew S. Suffoletto, Donald A. Severyn, John Gorcsan, III, University of Pittsburgh, Pittsburgh, PA

**Background:** Assessment of left ventricular (LV) dyssynchrony to predict response to cardiac resynchronization therapy (CRT) can be complex and time consuming. Our objective was to test a rapid and simple index using the new technique of color-coded strain dyssynchrony imaging.

**Methods:** Ten open-chest dogs had mid-LV short axis views (Aplio 80, Toshiba Corp) using angle-corrected strain dyssynchrony imaging which color-codes time-to-peak radial strain in real-time. Data were recorded during baseline and pacing at multiple sites to induce variable degrees of dyssynchrony including the right ventricle to simulate left bundle branch block (LBBB) and biventricular (BIV)-pacing. The new dyssynchrony index was defined as the time difference from earliest to latest peak strain, and was compared to the 6-site standard deviation (Yu Index), previously shown to predict response to CRT in humans.

**Results:** The LBBB model resulted in dyssynchrony (238±39 ms, and 36±29 ms during baseline) characterized by early peak strain in the anterior-septum and late peak strain in the free wall. Dyssynchrony improved with BIV-pacing (49±24 ms, p<0.005 vs. LBBB model). The new dyssynchrony index was strongly correlated with the 6-site standard deviation (Yu Index), r=0.98.

**Conclusion:** A new rapid and simple index of LV dyssynchrony strongly correlated with multi-site standard deviation, previously shown to predict response to CRT in humans. Color-coded strain dyssynchrony imaging has potential for clinical applications.



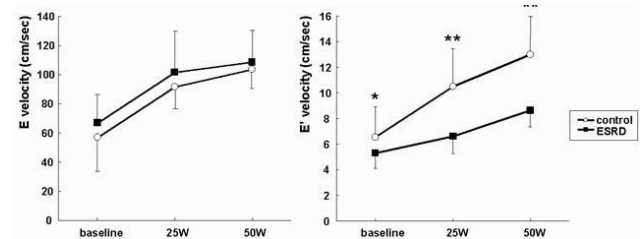
4:45 p.m.

823-6

**Left Ventricular Longitudinal Diastolic Function And Functional Reserve Are Reduced in Patients With End Stage Renal Disease**

Jong-Won Ha, Shin-Wook Kang, Jin-Mi Kim, Jeong-Ah Ahn, Seok-Min Kang, Se-Joong Rim, Namsik Chung, Yonsei University College of Medicine, Seoul, South Korea

Abnormalities of the left ventricular (LV) diastolic function are common in patients with end-stage renal disease (ESRD). In patients with diastolic dysfunction, the abnormal relaxation velocity-versus-heart rate relationship prevents augmentation of relaxation velocity as heart rate increases during exercise. Doppler tissue imaging (DTI) has been introduced as a method to evaluate diastolic function or myocardial relaxation by measuring mitral annulus velocity during diastole. The purpose of this study was to evaluate resting diastolic function and diastolic functional reserve during exercise in patients with ESRD using conventional Doppler and DTI. Mitral inflow and septal mitral annular velocities were measured at rest and during supine bicycle exercise (25W, 3 minutes increments) in 22 patients (15 male, mean age 53 years) with ESRD and 29 patients (7 male, mean age 58 years) with control. There were no significant differences in mitral inflow velocities (E, E/A, DT) between the two groups except A velocity, which was significantly higher in patients of ESRD. However, early diastolic mitral annular velocity (E') at rest and change of E' with exercise was significantly lower in patients with ESRD compared with control. In conclusion, unlike conventional mitral inflow parameters, LV longitudinal resting diastolic function and diastolic functional reserve during exercise assessed by DTI were significantly reduced in patients with ESRD.



5:00 p.m.

823-7

**Ischemia-Induced Increase in Myocardial Stiffness Modulates Postsystolic Shortening**

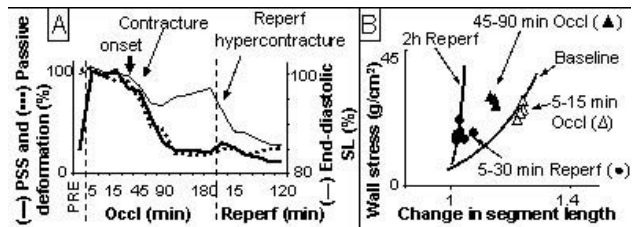
Cristina Pislaru, Mayo Clinic College of Medicine, Rochester, MN

**Background:** Postsystolic shortening (PSS) is a potential marker of myocardial viability. In this study, we investigated the mechanism of the decrease in PSS during prolonged ischemia.

**Methods:** Eight pigs were subjected to 3h of LAD occlusion and 2h reperfusion (transmural myocardial infarction). Segment length (SL) and LV chamber diameters were measured by sonomicrometry. Changes in myocardial stiffness were evaluated from exponential diastolic stress-strain relationship by varying preload (caval constriction and saline infusion) as well as by changes in regional passive deformation (late diastole; D<sub>2</sub>).

**Results (mean±SE):** In the ischemic segment, PSS increased from 2±1% (baseline) to 16±2% at 5-15min occlusion (Fig.A); thereafter, it gradually decreased (4±1% at 3h occlusion). Temporal changes in PSS were strongly related to changes in D<sub>2</sub> (R<sup>2</sup>=0.96, P<0.0001). LV diameters and D<sub>2</sub> of normal segment remained constant. The onset of ischemic contracture (decrease in end-diastolic SL during occlusion; onset at 40±8min; full effect within 30min) accelerated the decline in PSS and D<sub>2</sub> magnitudes (Fig.A). Contracture and edema formation were responsible for leftward shifts in stress-strain relationship towards increased myocardial stiffness (Fig.B). Water content (tissue samples) was higher in reperfused infarcts (p<0.0001 vs. normal).

**Conclusions:** Changes in PSS during prolonged ischemia reflect changes in myocardial viscoelasticity brought by ischemic contracture and myocardial edema.



5:15 p.m.

823-8

### Abnormal Left Ventricular Longitudinal Contractile Reserve In The Presence Of Hyperdynamic Radial Contraction In Patients With Hypertrophic Cardiomyopathy: Assessment With Pulsed-wave Tissue Doppler Exercise Echocardiography

Jong-Won Ha, Namsik Chung, Jin-Mi Kim, Jeong-Ah Ahn, Seok-Min Kang, Se-Joong Rim, Yangsoo Jang, Won-Heum Shim, Seung-Yun Cho, Yonsei University College of Medicine, Seoul, South Korea

**Background:** In patients with hypertrophic cardiomyopathy (HCM), global left ventricular (LV) systolic function appears normal or hyperdynamic when assessed with conventional radial contractile parameters, such as fractional shortening or ejection fraction (EF). LV longitudinal contraction results in apical displacement of the mitral annulus and it can be quantified using pulsed wave tissue Doppler imaging. Since pathologic LV hypertrophy is associated with myocardial fibrosis, particularly in the subendocardium, we hypothesized that mitral annular systolic velocity (S') at rest and during exercise would be abnormal in patients with HCM.

**Methods and Results:** S' was measured at rest and during graded supine bicycle exercise (25W, 3 minutes increments) in 20 patients (16 male, mean age 55 years) with HCM and 43 patients (14 male, mean age 57 years) with control. LVEF was calculated from the echocardiographic m-mode from short axis image. LVEF at rest was significantly higher in patients with HCM compared with that of control (71±7 vs 66±9%, p=0.0098). Although there was no significant difference in S' at rest between the groups (5.9±1.3 vs 6.3±1.2 cm/s, p=0.32), S' during exercise (6.4±1.5 vs 7.9±2.4 cm/s at 25 W, p=0.005; 7.0±1.4 vs 9.1±2.0 cm/s at 50 W, p<0.0001) and change of S' with exercise (0.5±0.9 vs 1.6±1.8 cm/s from base to 25W, p=0.003; 0.9±1.2 vs 2.7±1.6 cm/s from base to 50W, p<0.0001) was significantly lower in patients with HCM compared with control. In conclusion, even though radial contraction is more vigorous in patients with HCM, their longitudinal contraction and contractile reserve during exercise is reduced. The assessment of longitudinal function should be incorporated for the comprehensive evaluation of LV systolic function and maybe the better parameter for earlier detection of LV contractile dysfunction.

## ORAL CONTRIBUTIONS

### 834 Contrast-Enhanced Magnetic Resonance Imaging: Assessment of Microvascular Damage and Infarction

Tuesday, March 08, 2005, 8:30 a.m.-10:00 a.m.  
Orange County Convention Center, Room 414A

8:30 a.m.

834-3

### Delayed Contrast Enhancement and No-Reflow Phenomenon in Acute Myocardial Infarction

Oliver Bruder, Kai U. Waltering, Markus Jochims, Peter Hunold, Georg V. Sabin, Jörg Barkhausen, University Hospital, Essen, Germany, Elisabeth Hospital, Essen, Germany

**Background:** After acute infarction, microvascular obstruction detected by MRI predicts more frequent cardiovascular complications. Aim of our study was to investigate the optimum time point for assessment of no-reflow zones and the area of delayed contrast enhancement.

**Method and Materials:** 41 patients (31 male, 10 female, mean age 58±13 years) with first acute ST-elevation myocardial infarction (MI) were included into the study. All patients underwent percutaneous coronary intervention resulting in TIMI grade 3 flow. MR imaging was performed on a 1.5T MR-system 2.8±1.8 days after MI. One, 2, 3, 5, 10, 15 and 20 minutes after Gadodiamide injection (0.2 mmol/kg BW, Omniscan, Amersham) the entire left ventricle was covered in a single breath-hold using a single shot inversion-recovery steady state free precession (IR-SSFP) sequence (TR 2.4 ms, TE 1.1 ms, FA 50°). The area of delayed enhancement (DE) and the no-reflow zone were measured by planimetry for all different time points after contrast administration.

**Results:** The IR-SSFP sequence demonstrated DE of the anterior wall in 19 and the infero-lateral wall in 22 patients. The mean infarct size defined as area of DE continuously increased within the first 10 minutes from 13.3±13.2% to 18.5±14.0% at 10 min post contrast and remained unchanged thereafter. Immediately after contrast injection no-reflow areas were detected in 26 patients (63.4%) with a mean infarct size of 24.1±14.2% of LV mass. Only 15 patients with smaller infarct size (6.0±7.3% of LV mass) showed no microvascular obstruction. The extent of the no-reflow zones significantly decreased over time (11.6±8.6% at 1 min p.i. to 4.1±5.8% at 20 min p.i.).

**Conclusions:** Our results show a higher incidence of microvascular obstruction compared to previous studies because we covered the entire left ventricle with high spatial resolution immediately after contrast injection. Delayed measurements underestimate the no-reflow zones, because the extent significantly decreases over time. However, DE imaging requires a delay of at least 10 minutes.

8:45 a.m.

834-4

### Duration Of Ischemia Is A Major Determinant Of Transmurality And Microvascular Obstruction Assessed By Magnetic Resonance After Primary Angioplasty

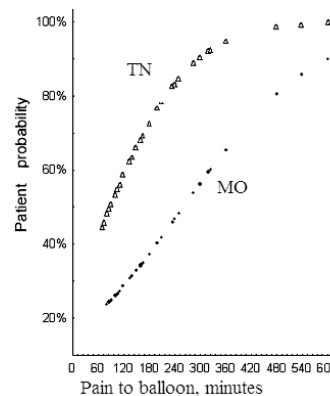
Giuseppe Tarantini, Luisa Cacciavillani, Angelo Ramondo, Massimo Napodano, Francesco Corbetti, Claudio Bilato, Martina Perazzolo, Enrico Bacchiega, Renato Razzolini, Sabino Iliceto, University of Padova, Padova, Italy

**Background:** Late reperfusion results in less myocardial salvage and higher mortality, irrespective of the chosen reperfusion strategy. The impact of ischemic time on the extent of myocardial and microvascular injury, is not well characterized. Aims: to address the relationship between duration of ischemia and both transmural myocardial necrosis (TN) and microvascular obstruction (MO), by contrast-enhanced magnetic resonance (CE-MR), in patients with acute myocardial infarction (AMI) treated with primary angioplasty (PCI) and to estimate the risk of TN and MO obstruction for each 30-minute delay in treatment.

**Methods:** Sixty-four patients presenting first ST-segment elevation AMI, within 12 hours from symptom onset, and treated by PCI because of TIMI flow <3 of infarct related artery underwent CE-MR within 5±3 days. AMI was defined as TN if CE-MR hyperenhancement was extended to at least 75% of the wall thickness ≥ 2 ventricular segments; MO was identified as discrete areas of hypo-enhancement surrounded by hyper-enhanced regions.

**Results:** Mean pain to balloon time was 90±40, 110 ± 107, 137 ± 97 minutes in patients with no TN and MO, with only TN or with TN and MO, respectively. By multivariate regression analysis, each 30-minute delay was significantly associated both with TN (odds ratio (OR)/30 minutes, 1.37, 95%CI 1.03-1.8 p=0.03), and MO (OR/30 minutes, 1.21; 95%CI 1.03-1.4, p=0.02) (Figure).

**Conclusion:** In AMI patients treated by PCI, every minute delay in reperfusion increases the risk of TN and MO.



9:00 a.m.

834-5

### Extent of Microvascular Obstruction Predicts Left Ventricular Remodelling in Reperfused Myocardial Infarction More Than Infarct Size: Study by Contrast Magnetic Resonance Imaging.

Antonella Lombardo, Luigi Natale, Francesca Gabrielli, Alessandra Porcelli, Gaetano Lanza, Leonarda Galuto, Vittoria Rizzello, Lorenzo Bonomo, Filippo Crea, Catholic University, Rome, Italy

**Background:** left ventricular (LV) remodelling is crucial in clinical outcome after acute myocardial infarction (AMI). Infarct size, microvascular obstruction (MO) and myocardial viability are involved in the process of remodelling. However, the individual role of each of these components is unknown. Gadolinium-enhanced Magnetic Resonance Imaging (Gd-MRI) allows to detect tissue edema of the infarct zone, MO (first-pass and/or delayed hypo-enhancement) and infarct size (delayed hyperenhancement). Aim of this study was to assess the role of MO and infarct size in the LV remodelling.

**Methods:** 25 patients with AMI reperfused by primary coronary stenting (22 with TIMI 3 and 4 with TIMI 2 flow) were studied. End-diastolic (EDV) and end-systolic (ESV) LV volumes were assessed by Simpson's method on echocardiography within 24 hours and at 1-month follow-up. A >20% increase of EDV and/or ESV was considered indicative of LV remodelling. MRI was performed within 3 days with a 1.5 T scanner, using triple IR-prep fast spin echo sequence for edema evaluation, steady-state free precession cine sequence (FIESTA) for contractile function, fast-gradient echo train for first-pass perfusion study and IR-prep fast gradient echo for delayed enhancement assessment. For first-pass study, gadolinium-DTPA was administered at dosage of 0.075 mmol/Kg (3 ml/sec) and repeated at the end of first-pass imaging. Delayed enhancement was evaluated after 15 min. Extent of edema, MO and hyperenhancement were evaluated using a score index on the basis of their transmural extension (<25%, 25-50%, 50-75%, >75%) in each segment of a 17-segments LV model.

**Results:** at follow-up 11 patients had LV remodelling. EDV and ESV increased from 106±30 ml to 153±36 ml and from 60±17 ml to 91±23 ml respectively in patients with LV

remodelling. MO was detected in 22 patients (88%). The score indexes for edema, MO and hyperenhancement were  $4.0 \pm 1.6$ ,  $2.4 \pm 1.1$ ,  $3.3 \pm 1.6$  respectively in patients with LV remodelling and  $2.9 \pm 2.2$  (p: NS),  $1.4 \pm 0.9$  (p: 0.04),  $2.6 \pm 1.7$  (p: NS) respectively in patients without LV remodelling. **Conclusions:** In reperfused AMI Gd-MRI detects an high incidence of MO. The effects of MO on LV remodelling are stronger than those of infarct size.

9:15 a.m.

**834-6 Human Infarct Scar Formation at 7 Months is Related to the Presence and Extent of Microvascular Obstruction Acutely. A Magnetic Resonance Imaging Study.**

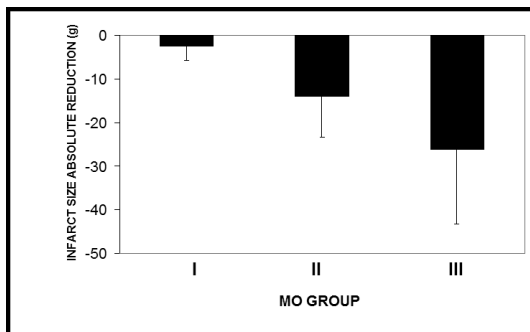
Andre Schmidt, Caterina Silva, Clerio Azevedo, Sandeep Gupta, David A. Bluemke, Thomas K. Foo, Joao A.C. Lima, Katherine C. Wu, Johns Hopkins University, Baltimore, MD

Acute myocardial infarcts (AMI) by contrast enhanced imaging (ceMRI) shrink over time as scar healing occurs. Particularly in larger infarcts, this shrinkage can lead to thinner scar and adversely affect LV remodeling, as shown in animal studies. The presence or absence of microvascular obstruction (MO) relates to thinner scar and adverse LV remodeling after AMI because of regional changes in myocardial deformation. The relation between acute MO extent and extent of infarct shrinkage has not been previously examined.

**METHODS:** 44 patients underwent ceMRI 3.3±2.7 days after first MI and 7 months later. MO extent was measured on first pass perfusion images using a hybrid echo-planar fast gradient echo (FGRE) sequence after 0.1 mmol/kg Gadodiamide. A second 0.1 mmol/kg bolus was given and on delayed enhancement images using inversion recovery FGRE, infarct size (IS) was measured using custom software (CINE Tool, GE). Patients were grouped by MO extent expressed as % of total LV mass (Group I: no MO, n=8; Group II: <15%, n=24; Group III: ≥15%, n=12). ANOVA comparisons were used.

**RESULTS:** MO extent in the 3 groups was 0%, 7.8±3.7%, and 21.3±5.4%, respectively. At 7 months, absolute change in IS mass was -2.7±3.0g, -14.1±9.2g, and -26.3±16.9g, respectively (ANOVA <0.0001) with significant between groups differences (p<0.05 for all).

**CONCLUSIONS:** Absence of MO predicts very little reduction of IS at 7 months. The presence and extent of MO correlates directly with IS shrinkage.



9:30 a.m.

**834-7 Ability Of MRI Infarct Size To Identify Acute MI Patients Who Will Have Persistently Low Ejection Fraction**

Caterina Silva, Andre Schmidt, Clerio Azevedo, Bernhard Gerber, Thomas K. Foo, David A. Bluemke, Joao A.C. Lima, Katherine C. Wu, Johns Hopkins University, Baltimore, MD

Although clinical parameters can predict prognosis after acute myocardial infarction (AMI), none identifies patients who will have chronically reduced ejection fractions (EF). This is pertinent in light of recent data supporting prophylactic implantable cardioverter defibrillator (ICD) placement in ischemic cardiomyopathy patients. However, patients with recent MI (<30 days) usually are excluded from early ICD placement because of recovery of function from myocardial stunning. We aimed to investigate whether MRI variables in the acute setting identifies patients who will have persistent LV dysfunction.

**Methods:** 43 patients had MRI 3±3 days and 10±6 months after AMI. Microvascular obstruction (MO) extent was measured on first pass perfusion images using hybrid echo-planar fast gradient echo (FGRE) after 0.1 mmol/kg gadodiamide. After a second 0.1 mmol/kg bolus, infarct size (IS) was measured on delayed enhancement images using inversion recovery FGRE. Patients were grouped by EF at follow-up [group I: EF<40%, n=11 (mean EF 35±6%); group II: EF≥40%, n=32 (mean 52±8%)]. MO and IS were expressed as % total LV mass. Linear regression and ROC analysis were performed.

**Results:** EF in the acute and chronic phases were highly correlated (r=0.74, p<0.05). However 44% (7/16) of patients with EF<40% acutely had functional recovery to EF≥40% at follow-up.

IS and EF were highly correlated acutely (r=0.72, p<0.05) and at follow-up (r=0.69, p<0.05). MO and EF in the acute phase were modestly correlated (r=0.55, p<0.05).

Acutely, groups I and II had significantly different IS ( $35 \pm 14.5\%$  vs  $20 \pm 11.0\%$  p<0.05), but only a border-line trend in MO differences ( $13 \pm 9.9\%$  vs  $8 \pm 7.6\%$ , p=0.08). IS at 10 months was also different between groups ( $26 \pm 8.4\%$  vs  $14 \pm 9.1\%$ , p<0.05). From ROC analysis, acute IS and MO predicted EF<40% acutely [for IS: sensitivity (Sen) 94%, specificity (Sp) 67%; for MO: Sen 81%, Sp 78%] and IS also predicted EF<40% at follow-up [IS: Sen 91%, Sp 69%, cut-off 26%].

**Conclusion:** MRI infarct size in the acute MI setting can predict global LV dysfunction (EF<40%) in both acute and chronic phases post-infarct. This finding may facilitate early risk stratification in such patients.

**834-8**

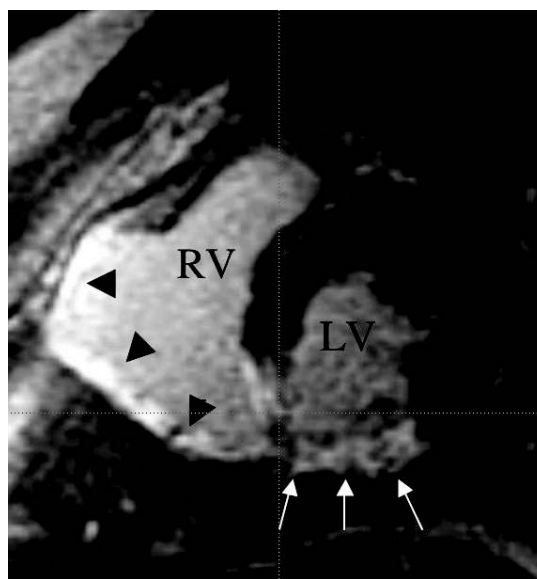
**Cardiac Magnetic Resonance Imaging Detects Acute Right Ventricular Myocardial Infarction**

Andreas Kumar, Hassan Abdel-Aty, Ilka Kriedemann, Jeanette Schulz-Menger, C. Michael Gross, Rainer Dietz, Matthias G. Friedrich, Charite Franz-Volhard-Klinik, Humboldt University, Berlin, Germany

**Background:** Right ventricular infarction (RVI) is a serious complication of acute inferior myocardial infarction. Delayed enhancement cardiovascular magnetic resonance imaging (CMR) accurately detects acute left ventricular infarction. We investigated the utility of delayed enhancement CMR for the detection of acute RVI.

**Methods:** We examined 42 consecutive patients with acute inferior myocardial infarction defined by ECG criteria. All underwent a physical examination for the presence of a triad of hypotension, clear lung sounds and jugular venous distension, an ECG for ST-elevation ≥0.1mV in the V4r right precordial lead, and an echocardiogram (n=36). After coronary reperfusion, all patients underwent a CMR examination evaluated by two blinded observers for the presence of delayed enhancement in the right ventricular wall.

**Results:** The sensitivity and negative predictive values of CMR for the detection of RVI, compared to clinical triad, ECG V4r, and echocardiography were 89%, 91%, 100% and 95%, 95%, 100%, respectively; the specificities were 61%, 66% and 55%. When the non-CMR examinations were combined, CMR reached a sensitivity of 88% and specificity of 78% when the standard of truth was ≥1 non-CMR methods as positive for RVI. CMR detected all patients, in who at least two non-CMR methods were positive for RVI (sensitivity 100%).



**Conclusion:** Delayed enhancement CMR yields high sensitivities and negative predictive values for the detection of RVI in acute inferior myocardial infarction.

POSTER SESSION

**1138 Echocardiography: Not One but Many Uses**

Tuesday, March 08, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 10:00 a.m.-11:00 a.m.

**1138-87**

**Intensive Multiple Risk Factor Intervention Reduces Progression of Aortic Sclerosis in Endstage Renal Failure**

Leanne Jeffriess, Brian A. Haluska, Rodel Leano, Nicole Isabel, Thomas H. Marwick, University of Queensland, Brisbane, Australia

**Background:** Pts with endstage renal failure (ESRF) are prone to the development of aortic sclerosis (AScl). We have recently validated an ultrasonic backscatter approach to quantify the degree of sclerosis, and sought whether an intensive program of multiple risk factor intervention could limit the progression of AScl.

**Method:** We randomized 200 pts with ESRF (mean age 56±12 years, 27 men, mean dialysis duration 1 year) to (i) conventional cardiovascular prevention (CONV; according to national guidelines) or (ii) intensive therapy (INT; LDL-C <77 mg/dl, homocysteine <2.0mg/l, blood pressure (<140/90), anemia (11.0-12.5 g/dl) and phosphate <4.95 mg/dl). In a subgroup of 43 pts, images of the aortic valve were obtained at baseline and after a follow up of 1.1±0.4 yrs in the parasternal long axis view and saved in raw data format.

Six square-shaped 11x11 pixel regions of interest (ROI) were placed on the anterior and posterior leaflets, and calibrated backscatter values were obtained by subtracting the regions of interest in the blood pool from the averaged backscatter values obtained from the leaflets. No patients had overt aortic stenosis at baseline or follow-up.

**Results:** Significant improvements from baseline were achieved in the IT group compared with CONV - serum LDL cholesterol (-31 mg/dl vs. -13 mg/dl;  $p=0.001$ ), homocysteine (-0.94 vs. -0.09 mg/l;  $p<0.001$ ), systolic BP (-6.9 vs. -0.2 mm Hg;  $p=0.049$ ) and diastolic BP (-4.8 vs. -1.0 mm of Hg;  $p=0.043$ ). At baseline, the calibrated backscatter signal was  $17.5\pm 5.7$  in CONV and  $15.2\pm 5.6$  in IT groups ( $p=NS$ ), compared with  $9.8\pm 3.3$  dB in normal valves. At follow-up, there was a significant increase in the CONV ( $19.8\pm 5.1$ ,  $p=0.04$ ), compared to no change in the IT group ( $16.2\pm 6.3$ ,  $p=NS$ ). Moreover, the backscatter intensity was greater at follow-up in the standard care group ( $p=0.05$ ).

**Conclusion:** Aortic sclerosis is common in ESRF. An intensive risk factor intervention program may reduce the progression of disease.

1138-88

### Clinical Evaluation of Isovolumic and Systolic Ejection Signals by Tissue Doppler Imaging for the Assessment of LV systolic Function

Ruan Qinyun, Sherif F. Nagueh, Baylor College of Medicine, Houston, TX

**Background:** Tissue Doppler imaging (TDI) is a valuable tool for assessment of left ventricular (LV) global and regional function. Recently, animal models have shown that myocardial acceleration (IVA) during isovolumic contraction (IVC) related well to invasive indices of LV contractility. However, there is a paucity of data on its clinical utility, particularly in comparison with systolic ejection (Sa) velocities.

**Methods:** We measured velocities during IVC and ejection as well as IVA in 70 patients ( $55\pm 19$  yrs, 33 women), including 40 control subjects (EF:  $65\pm 3\%$ ) without evidence of cardiovascular disease and 30 pts with depressed EF ( $28\pm 8\%$ ,  $p<0.001$  vs controls). TD data were analyzed from mitral annulus lateral and septal sites. IVA was derived as peak velocity during IVC divided by acceleration time from onset to peak IVC velocity.

**Results:** Pts. with depressed EF had a larger left atrial volume index ( $46\pm 16$  vs.  $23\pm 6$  ml/m<sup>2</sup>), increased LV mass index ( $132\pm 32$  vs.  $81\pm 13$  gm/m<sup>2</sup>) and lower early and late diastolic velocities at both sites of the mitral annulus (all  $p<0.005$ ). Likewise, Sa and IVC velocities, and IVA at both sides of the mitral annulus were all significantly lower in the group with depressed EF (for IVA as average of both sites:  $159\pm 53$  vs.  $244\pm 84$  cm/s<sup>2</sup>,  $p<0.001$ ). IVA had no significant correlation with age, heart rate and systemic blood pressure ( $p>0.1$ ). The best correlation with EF was noted with the average of septal and lateral Sa ( $r=0.65$ ,  $p<0.001$ ), though IVC signals also had significant correlations ( $r$  ranging from 0.33 for IVC velocity at septal site to  $r=0.53$  for average IVA, both  $p<0.01$ ). Using ROC curves, area under ROC curve (AUC) was largest for average Sa at 0.92, significantly ( $p<0.05$ ) exceeding IVC velocity and IVA (AUC ranging from 0.7 for septal IVC velocity to 0.82 for average IVA).

**Conclusions:** While all of the investigated TDI derived signals are of value for evaluating LV systolic function, Sa velocity provided a better assessment of EF than IVC velocity and acceleration. In the context of these results and given the need for only a single measurement for Sa velocity (versus 2 for IVA), Sa velocity appears to be the more suitable signal for routine clinical application.

1138-89

### Left Atrial Diameter is independently predictive of Cardiovascular Death in patients with Chronic Renal Failure

Mark Y. Chan, Hwee Bee Wong, Hean Yee Ong, Tiong Cheng Yeo, National University Hospital, Singapore, Singapore, Clinical Trials Research and Epidemiology Unit, Singapore, Singapore

**Background:** Patients with chronic renal failure (CRF) have high cardiovascular risk. Left atrial (LA) volume has been shown to predict cardiovascular events. It is unknown if LA diameter has the same prognostic value especially in patients with CRF.

**Methods:** We performed echocardiography and SPECT in 200 patients with CRF (creatinine clearance  $< 60$  ml/min) without a prior history of ischemic heart disease or pathological Q waves on electrocardiogram. The anterior-posterior LA diameter was measured by M-mode echocardiography and indexed to body surface area. We analyzed clinical, echocardiographic and SPECT variables to assess their value in predicting cardiovascular death.

**Results:** The mean age of the study population was  $61\pm 12$  years, mean creatinine clearance was  $17\pm 11$  ml/min and mean indexed LA diameter was  $24\pm 9$  mm/m<sup>2</sup>. During a mean follow up period of  $3.2\pm 1.4$  years, 25 patients (12.5%) reached the endpoint. In multivariate analysis adjusting for clinical, echocardiographic and SPECT variables, indexed LA diameter  $\geq 24$  mm/m<sup>2</sup> was independently predictive of cardiovascular death (Hazard Ratio, HR 2.75, CI 1.14-6.59,  $p=0.016$ ) (figure 1). Each mm/m<sup>2</sup> increase in indexed LA diameter was associated with a HR of 1.13 (95% CI 1.04 -1.24,  $p=0.005$ ).

**Conclusion:** In patients with CRF, indexed LA diameter is an independent and powerful predictor of cardiovascular death.

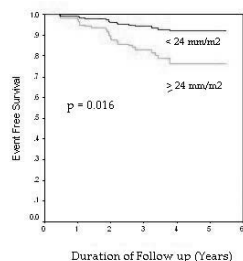


Figure 1. Kaplan-Meier plot of event-free survival according to indexed LA diameter

1138-90

### The Preload Independence of a New Parameter to Evaluate Left Ventricular Diastolic Function

Sang-Yong Yoo, Eun-Ah Choi, Jung-Hyun Choi, Heungsoo Kim, Gyu-Tae Shin, So-Yeon Choi, Myeong-Ho Yoon, Gyo-Seung Hwang, Seung-Jea Tahk, Joon-Han Shin, Ajou University School of Medicine, Suwon, South Korea

**Background:** The time interval between the onsets of mitral inflow and mitral annulus velocity ( $T_{E-E}$ ) has been proposed as a new index representing left ventricular (LV) relaxation and related to LV filling pressure. This index has been reported as a preload independent parameter in experimental canine model. The impact of preload on this index, however, has not been studied in human.

**Methods:** Thirty-four patients (19 men, mean  $50\pm 14$  years) who have end-stage renal disease and normal systolic function (EF  $\geq 50\%$ ) underwent echocardiography immediately before and after hemodialysis (HD). Early (E) and late (A) transmitral inflow velocity, mitral annulus velocity (E') and flow propagation velocity (Vp) were evaluated.  $T_{E-E}$  was measured by time interval of peak R to onset of E minus time interval of peak R to onset of E'. Corrected  $T_{E-E}$  were calculated after correction by the heart rate (using the  $\sqrt{R-R}$  interval).

**Results:** The mean ejection fraction was  $68\pm 10\%$ . Average weight reduction by HD was  $3.0\pm 1.3$  (range 0.5-6.4) kg. The dimensions of LV end-diastole, left atrium and inferior vena cava were reduced significantly as  $2.5\pm 2.9$ ,  $2.5\pm 5.1$ , and  $4.5\pm 4.2$  mm, respectively ( $p<0.001$ ). The table shows the changes of Doppler-Echo parameters after HD.

**Conclusion:** A new parameter for diastolic function, time interval between the onsets of mitral inflow and mitral annulus velocity appears to be preload-independent in patients with normal systolic function.

	Pre-HD	Post-HD	p
E (cm/sec)	103.8 $\pm$ 31.5	69.3 $\pm$ 21.9	<0.001
E/A ratio	1.1 $\pm$ 0.6	0.9 $\pm$ 0.7	<0.001
E' (cm/sec)	10.4 $\pm$ 3.12	9.3 $\pm$ 3.5	0.004
Vp (cm/sec)	48.9 $\pm$ 15.5	41.0 $\pm$ 15.2	0.021
E/E'	10.6 $\pm$ 4.7	8.2 $\pm$ 4.2	<0.001
E/Vp	2.3 $\pm$ 1.0	1.9 $\pm$ 0.7	0.011
corrected $T_{E-E}$ (msec)	0.8 $\pm$ 0.5	0.5 $\pm$ 1.4	NS

1138-91

### Error of Cardiac Output Measured by Doppler Ultrasound and the Method of Correction

Tiesheng Cao, Kang Ding, Hong Wang, Lijun Yuan, Yunyou Duan, Zuojun Wang, Department of Ultrasound Diagnostics, Tangdu Hospital, Fourth Military Medical University, Xi'an, People's Republic of China

**Background:** Blood flow velocity measured by Doppler ultrasound represents the net motion of the blood relative to the transducer. When the transducer is placed on the apex and directed to the aortic annulus to measure the aortic blood velocity, the motion of the annulus along the cardiac long axis will be added to the flow velocity and what we measured is the modified flow velocity. However, what we intend to measure is the velocity that is relative to the annulus. To prove that these two velocities are different and to find a way to correct the error, we designed this study to have the transducer moved synchronously with the aortic annulus to obtain the true flow velocity.

**Methods:** We made a cardiac motion simulator (CMS) that can accurately simulate the mechanical motion of the aortic annulus relative to the cardiac apex. Twenty-six normal subjects were included in this experiment. M-mode echocardiography is used to obtain the motion data of the aortic annulus of each individual and then CMS was adjusted to simulate the motion amplitude and the duration according to the data. The transducer was fixed on the arm of CMS that may move the transducer in the motion pattern of the aortic annulus. The transducer was placed on the normal five-chamber-view window through a water-balloon. Moving synchronously with the aortic annulus, the transducer was relative still to the annulus and thus the true aortic blood flow spectrum was obtained. The velocity time integral (VTI) of these true blood flow velocity and of the flow velocity from routine method were compared.

**Results:** The VTI of the true aortic flow velocity were about  $16.8\pm 3.4\%$  higher than that of the velocity from routine method. In this study, we found that the Doppler signals depicting the aortic annulus motion were also in the Doppler spectrum and may be used to correct the error.

**Conclusion:** Cardiac output is underestimated due to cardiac motion opposite to the flow direction and can be corrected by adding of the VTI of the annulus motion to the VTI of aortic blood flow. We actually overestimated aortic Doppler flow routinely by measuring the outer edge of the spectrum. The routine method seems to be accurate because the two errors are in the opposite direction and cancel each other.

1138-92

### Enhancement of Coronary Artery Endothelial Cell Angiogenesis by Pulsed Wave Diagnostic Ultrasound Is Frequency Dependant

Curtiss Stinis, Faramarz Tehrani, Michael Jones, Andrzej Tarnawski, P. Anthony Chandraratna, Long Beach VA Medical Center, Long Beach, CA, University of California, Irvine, Irvine, CA

**Background:** We have previously demonstrated that pulsed wave diagnostic ultrasound enhances angiogenesis of human coronary endothelial cells in vitro when administered at a frequency of 1.6MHz for 1 hour. This study was designed to test the hypothesis that the effect of ultrasound-induced enhancement is frequency dependant.

**Methods:** Human coronary artery endothelial cells grown to reach 80% confluency in Clonetics EGM-2MV medium were used. The cells were incubated for 24 hours in serum depleted growth medium (0.1% FBS) containing no added growth factors, then trypsinized and plated in 24-well tissue culture plates coated with growth factor-reduced Matrigel. The cells were then exposed to ultrasound by placing the plate on either a

1.6Mhz transducer set at a mechanical index of 1.5 for 1 hour or a 8Mhz transducer at a mechanical index of 1.5 for 1 hour. Paired control plates were also placed on a transducer which was not activated. Experiments were repeated on 6 separate days. Endothelial cell migration and formation of capillary-like structures reflected in vitro angiogenesis. The plated cells were photographed at 1 hour and 6 hours following exposure and the number of capillary loops was counted.

**Results:** Pulsed wave diagnostic ultrasound administered at a frequency of 1.6 Mhz significantly stimulated angiogenesis as compared to cells exposed to ultrasound at 8Mhz or to unexposed cells. Cells exposed to 1.6Mhz demonstrated a 360% increase in capillary loop formation at 6hrs post-exposure as compared to controls ( $p=0.02$ ), whereas cells exposed to 8Mhz demonstrated only a 2% increase in capillary loop formation 6 hours post-exposure as compared to controls ( $p=0.9$ ).

**Conclusion:** Enhancement of in vitro angiogenesis of human coronary artery endothelial cells by pulsed wave diagnostic ultrasound is frequency dependant.

### 1138-93 Serum Interleukin-6 And Interleukin-1beta Levels Are Inversely Correlated With Coronary Flow Reserve In Young Healthy Volunteers

Li-ming Gan, Ulrika Hägg, Lennart Svensson, Regina Fritsche-Danielson, Birger Wandt, Cardiovascular institute, Göteborg, Sweden

**Background:** Transthoracic colour Doppler echocardiography has been used to assess coronary flow velocity reserve in all the three major coronary arteries in man. In absence of significant coronary artery stenosis, the adenosine-induced flow increase may at least in part reflect endothelial function in the coronary vascular bed. Inflammation has now been recognized as an important factor affecting on peripheral vascular function in man. In the present study, we explored possible impact of inflammatory cytokines on coronary flow reserve (CFR) in young healthy volunteers.

**Methods:** Using the latest generation ultrasound imaging platform, resting and adenosine-induced (140 µg/kg/min) hyperaemic coronary flows were recorded in all the three major coronary arteries in 19 healthy volunteers with an average age of 25.8±0.8 years. CFR was calculated as the ratio between hyperaemic and baseline mean diastolic flow velocities in the respective coronary artery. Mean coronary flow reserve (mCFR) was averaged from the CFR values from respective coronary artery. Twelve inflammatory markers were assessed simultaneously using Randox biochip array technology. Cholesterol, lipoprotein fractions as well as high-sensitive CRP (hsCRP) were analysed.

**Results:** Average CFR values were similar between males and females, and were 3.5±0.1, 2.7±0.2 and 2.7±0.1 in the left anterior descending, left circumflex and right posterior descending coronary arteries, respectively. mCFR was 3.0±0.1 in the study population. Serum IL-6 level was 4.6±2.9 pg/ml and the quartiles of IL-6 levels were inversely correlated with mCFR ( $p=0.009$ ), independently of traditional risk factors, e.g. cholesterol, LDL, apoB, age, CRP and systolic blood pressure. mCFR values were significantly lower in subjects with IL-1beta values from the upper median compared to the lower median. (mCFR, IL-1beta upper median versus lower median: 2.7±0.1 versus 3.1±0.1,  $p=0.026$ ).

**Conclusions:** Inflammatory cytokines are independent determinants of coronary vascular function in young healthy volunteers. CFR seems to be a sensitive and simple method to assess coronary artery function in man.

### 1138-94 Catheter/Doppler Discrepancies in Aortic Stenosis Can Be Estimated Non-invasively: Practical Implications for Evaluation of Aortic Stenosis in the Clinical Setting

Melissa Daubert, Jennifer Liu, Vittorio Palmieri, Lawrence Ong, Smadar Kort, David Rosman, Rebecca Hahn, North Shore University Hospital, Manhasset, NY, Federico II University Hospital, Naples, Italy

**Background:** Discrepancy between catheterization (cath) and echo Doppler (Dop) measurement of aortic stenosis (AS) severity is encountered regularly in clinical practice. However, whether this difference can be predicted non-invasively using echo measured variables in the clinical setting remains unclear. Objective: To determine whether differences between cath and echo Dop measured peak pressure gradient (PG) and aortic effective orifice area (EOA) can be predicted by using previously validated formulas for pressure recovery (PR) and energy loss coefficient (ELCo).

**Methods:** Retrospective analysis of 69 patients with various degrees of AS who underwent both echo and cath with a mean interval of 22 days (range 0-197) between the two tests. Pressure recovery was estimated from Dop measured peak transaortic gradient, EOA and cross sectional area (CSA) of the ascending aorta and compared with observed differences between cath and Dop PG. Energy loss coefficient was calculated from EOA (Dop) and CSA of the aortic root at the sinotubular junction.

**Results:** Both peak and mean Doppler gradients (66 ± 27, 38 ± 18 mm Hg, respectively) were higher than cath gradients (41 ± 25, 34 ± 18 mm Hg, respectively). Predicted difference between peak Dop and cath PG due to PR ranged from 5 to 24 mm Hg (mean 13 ± 4 mm Hg) and correlated well with the observed difference between Dop and cath gradients ( $r=0.58$ ,  $p<0.001$ ). Corrected Dop gradient (peak Dop gradient - PR) showed good agreement with cath gradients ( $r=0.77$ ;  $p<0.001$ ). Calculated EOA (Dop) (range 0.3 - 1.7 cm<sup>2</sup>) correlated well with EOA (cath) (range 0.3 - 2.7 cm<sup>2</sup>) ( $r=0.6$ ;  $p<0.001$ ) but EOA (Dop) generally underestimated EOA (cath). Calculated ELCo (range 0.28 - 2.4 cm<sup>2</sup>) showed similar correlation ( $r=0.61$ ,  $p<0.001$ ) with EOA (cath) but underestimation was not observed.

**Conclusions:** Discrepancy between cath and Dop estimates of AS severity can be predicted noninvasively by echo in the clinical setting. Calculation of PR or ELCo could be performed when there is disagreement between cath and Dop estimates of AS.

## 1139 New Technology in Stress Echocardiography

Tuesday, March 08, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 10:00 a.m.-11:00 a.m.

### 1139-79 Transthoracic Doppler Echo Coronary Flow Reserve Noninvasively Diagnoses Left Anterior Descending Artery Patency In Left Bundle Branch Block.

George Athanasopoulos, Evdokia Petropoulou, George Hatzigeorgiou, George Karatasakis, Dennis V. Cokkinos, Onassis Cardiac Surgery Center, Athens, Greece

**INTRODUCTION:** The evaluation of left anterior descending artery (LAD) patency in left bundle branch block (LBBB) presents limitations with either scintigraphy or stress echo. Non-invasive assessment of coronary flow reserve (CFR) by transthoracic Doppler echo in the distal part LAD provides an alternative means. However its accuracy has not been established.

**METHODS:** Among 440 consecutive pts studied for LAD CFR, there were 57 pts with LBBB. 227/383 pts and 43/57 pts had coronary angiography performed within 3 months from the index echo (age 61±10 vs 62±11, ejection fraction 49±8 vs 36%±12). LAD diameter stenosis (>70%) was found in 7 (16%) with LBBB and in 76 (34%) without LBBB pts. The LAD distal flow was investigated by a modified 2 chamber apical view (GE 7 MHz transducer) nearby the apex. CFR was estimated from the diastolic time-velocity integral. Adenosine was infused at 140mg/kg/min for 4 min.

**RESULTS:** LBBB pts had lower diastolic velocity profile at R and ADEN (cm: 7.6±2.8 vs 8.8±3.7, and 17.4±8 vs 20±8, respectively,  $p<0.03$ ) but a similar CFR (2.32±0.7 vs 2.27±0.8). CFR values were similar irrespectively of LBBB: (LAD>=70% vs <70%: LBBB: 1.42±0.4 vs 2.5±0.6, nonLBBB: 1.24±0.5 vs 2.5±0.5)

CFR had a curvilinear regression with % LAD stenosis for both LBBB and nonLBBB pts (LBBB:  $R=0.66$ ,  $p<0.005$ , vs nonLBBB:  $R=0.77$ ,  $p<0.0001$ ).

CFR could reliably discriminate significant LAD stenosis irrespectively of LBBB. Using ROC analysis, the following diagnostic performance was found for the respective CFR cut off values (C-V): Non LBBB at C-V 1.8/1.9/2.0: sensitivity (SN) 0.93/0.93/0.91, specificity (SP) 0.92/0.85/0.80, area under curve (AUC) 0.96. With LBBB at C-V 1.8/1.9/2.0: SN 0.75/0.75/1, SP 0.94/0.88/0.83 and AUC 0.95 (all NS).

Linear regression between CFR and SP was similar for LBBB and nonLBBB pts. In contrast, the linear model for CFR and SN had a greater slope for LBBB pts ( $SN=0.40+0.67^*CFR$ ,  $R^2=0.85$  vs  $SN=0.40+0.26^*CFR$ ,  $R^2=0.75$ ).

**CONCLUSION:** In the presence of LBBB, CFR evaluation of distal LAD provides an accurate and convenient means to evaluate LAD patency. The accuracy remains unaffected in the range of CFR between 1.8-2.0, with a greater SN for LBBB in the upper limit of this range.

### 1139-80 Left Ventricular Wall Motion Abnormalities Induced by Squatting: A New Echocardiographic Stress Test for the Diagnosis of Coronary Artery Disease

Rajiv Maraj, Ghasan M. Tabel, Arash Vahdat, Lalkrushna Malaviya, Mandeep Brar, Shivanand Pole, P. Anthony Chandraratna, Long VA Medical Center, Long Beach, CA, University of California, Irvine, Irvine, CA

**Background:** This study was designed to test the hypothesis that increased afterload induced by squatting will produce left ventricular wall motion (wall thickening) abnormalities in patients with severe coronary artery stenoses.

**Methods:** The study population consisted of 11 normal subjects (Group 1) and 28 patients who were scheduled for coronary angiography for the evaluation of chest pain (Group 2). The Heart rate, blood pressure, and the echocardiogram in standard views were recorded in the standing position. The subjects were then asked to squat and the echocardiogram, blood pressure and heart rate were repeated. Echocardiography was repeated after the patients resumed the upright position. Regional wall motion was evaluated by two observers blinded to the results of coronary angiography.

**Results:** In Group 1 subjects, the heart rate (HR) changed from a baseline value of 82 +/- 16 beats/minute to 87 +/- 17 beats/minute ( $P=0.054$ ) and the systolic blood pressure (SBP) increased from 131 +/- 11 mmHg to 151 +/- 11 mmHg ( $P<0.0004$ ). In Group 2, HR increased from 81 +/- 14 beats/minute to 89 +/- 15 beats/minute ( $P=0.004$ ). The SBP increased from 125 +/- 20 mm Hg to 152 +/- 24 mm Hg ( $P<0.0001$ ). No wall motion abnormalities (WMA) were noted during squatting in Group 1 subjects. In Group 2, 15 patients developed akinesis or severe hypokinesis in the anterior septum, anterolateral wall or apex, 4 had WMA of the posterolateral wall, 7 had WMA of the inferior wall and 2 had no WMA (1 had a 55% LAD stenosis and the other had a 80% circumflex stenosis). All WMA resolved with standing. None of these patients developed chest pain or arrhythmias. Coronary angiography revealed severe stenosis (>70%) of the arteries supplying the segments that developed WMA.

**Conclusion:** These preliminary data indicate that squatting induces wall motion abnormalities in patients with critical coronary stenoses. Studies on a larger cohort are needed to determine the sensitivity and specificity of this method for the diagnosis of coronary artery disease.

**1139-81 Feasibility and Accuracy of Dobutamine Stress Echocardiography using Real-time 3D Echocardiography for Diagnosis of Coronary Artery Disease**

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**Background:** Dobutamine stress echocardiography (DSE) with 2D echocardiography (2DE) is one of time-consuming procedure for diagnosis of coronary artery disease (CAD). Moreover, accuracy of DSE with 2DE depends on operator skill or bias during the acquisition of the image to analyze. This study was done to determine the feasibility and accuracy of DSE with real-time 3D echocardiography (RT3DE) for diagnosis of CAD in comparison with 2DE.

**Methods:** Sixty two patients (RT3DE: 35, m : f = 26 : 9, age = 60 ± 11 yrs, 2DE: 27, m : f = 18 : 9, age = 60 ± 11 yrs) suspicious of angina pectoris underwent DSE and coronary angiography. Image acquisition was done at baseline, followed by 4 stages during Dobutamine infusion (10, 20, 30, 40 ug/kg/min, for 3 mins at each stage) and finally at recovery stage. In all patients, the procedure time (from the beginning of baseline to the end of peak dose stage) was recorded. Off-line regional wall motion analyses of volumetric images acquired with RT3DE was done using commercially available 3D computer software (TomTec, Co.). Digitized quad-screen images acquired with 2DE were analyzed off-line with commercially available 2DE review system (ProSolv 4.0). Images were analyzed according to the previously described 16 segment model and induced new or worsened wall motion abnormality in ≥2 contiguous segments during Dobutamine infusion was interpreted as ischemia. > 50 % luminal diameter stenosis of any coronary artery on coronary angiography was defined as significant coronary artery stenosis. Sensitivity and specificity were compared between two procedures.

**Results:** The procedure time of DSE with RT3DE was significantly shorter than that of 2DE (25.4 ± 3.4 vs 37.2 ± 4.3 mins, p < 0.01). DSE with RT3DE showed higher sensitivity (79% vs 67%) compared to DSE with 2DE. There was no significant difference of specificity (94% vs 94%) between those two procedures.

**Conclusion:** DSE with RT3DE seems to be a feasible and less time consuming diagnostic procedure providing better sensitivity for the detection of coronary artery stenosis compared to DSE with 2DE.

**1139-82 Feasibility of Using a Novel Real-Time Three-Dimensional Technique for Contrast Dobutamine Stress Echocardiography**

Todd Pulerwitz, Kumiko Hirata, Ryo Otsuka, Susan Herz, Khady Fall, Samyra Ali Rivera, Marie-Edouard N. Desvarieux, Margaret P. Bond, Marco R. Di Tullio, Shunichi Homma, Columbia Presbyterian Hospital, New York, NY

**Background:** Accurate wall motion assessment during stress echocardiography requires rapid acquisition of high quality echocardiographic images. Real-time 3-dimensional (RT3-D) transthoracic contrast echocardiography with full volume acquisition (Philips SONOS 7500) offers important potential advantages over standard 2-dimensional and non-contrast RT3-D echocardiography when assessing left ventricular wall motion. This is the first study using this system to evaluate the feasibility of RT3-D imaging using ultrasound contrast agent during pharmacological stress testing.

**Methods:** Thirteen patients undergoing dobutamine stress echocardiography (54% men; mean age 60 ± 14.2 years) were studied. Contrast and non-contrast apical full volume and short axis 3-dimensional images were obtained during rest and peak dose dobutamine infusion. Two experienced echocardiographers independently reviewed the images to assess image quality (adequate or inadequate) using standard 16 segment American Society of Echocardiography criteria.

**Results:** The use of ultrasound contrast significantly increased the number of segments adequately visualized during rest and peak dobutamine infusion (Table 1). The time to image optimization and acquisition with and without contrast use was less than 90 seconds.

**Conclusions:** RT3-D dobutamine contrast stress echocardiography 1) is feasible, 2) significantly improves image quality compared to non-contrast images, and 3) quickly acquires full data sets.

Table 1: Comparison of the Adequacy of Contrast and Non-Contrast RT3-D Images During Dobutamine Stress Echocardiography

	Apical		p-value	Apical and short axis		p-value
	Non-Contrast	Contrast		Non-Contrast	Contrast	
Rest	75%	96%	0.0001	92%	98%	0.004
Peak	75%	97%	0.0001	87%	99%	0.0001

**1139-83 Color-Encoding of Endocardial Motion Improves the Interpretation of Contrast-Enhanced Echocardiographic Stress Tests by Less Experienced Readers**

Lawrence D. Jacobs, Lissa Sugeng, Robert J. Weiss, Lynn Weinert, Tina Bouchard, Kirk T. Spencer, Marlon Everett, James Min, Michael Panutich, Roberto M. Lang, Victor Mor-Avi, University of Chicago, Chicago, IL, Androscoggin Cardiology Associates, Auburn, ME

Interpretation of contrast enhanced stress tests in pts with poor acoustic windows is challenging and subjective. We hypothesized that color encoding of endocardial motion would aid less experienced readers in detection of wall motion abnormalities at rest and stress in this population.

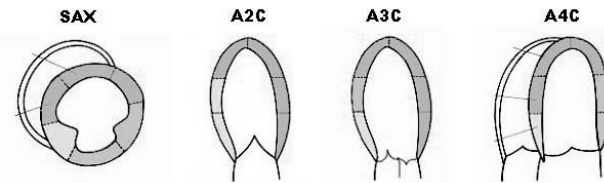
**Methods.** We studied 85 pts with poorly visualized endocardium in ≥2 contiguous segments in each apical view. Color-encoded images (Philips 7500, color kinesis) were obtained at rest and peak dobutamine stress in short axis and 3 apical views with iv infusion of Definity (Bristol-Myers Squibb). Two cardiology fellows with <6 months of training in echocardiography reviewed the images with color overlays suppressed and

then with the color displayed on a separate day. LV wall motion in each segment was graded as normal, abnormal or uninterpretable. Consensus grades of 2 experienced readers served as a "gold standard". The accuracy of the interpretation was calculated against this "gold standard" separately for the 3 vascular territories (LAD, LCX, RCA) and averaged for the 2 fellows.

**Results.** With color coded information available: 1) the number of uninterpretable segments decreased by 32%; 2) both fellows reached higher levels of accuracy in all 3 vascular territories both at rest and stress (fig.).

**Conclusion.** The addition of wall motion color encoding to Definity-enhanced images obtained in pts with poor acoustic windows during stress tests improves the interpretation of regional LV function by less experienced readers.

	Rest		Peak stress	
	Contrast only	Contrast + color	Contrast only	Contrast + color
LAD	73%	77%	71%	76%
LCX	77%	80%	74%	85%
RCA	75%	83%	75%	78%



**1139-84 Effect of Perfusion Imaging During Dobutamine Stress Echocardiography in Detecting Occult Coronary Artery Disease in Patients With Advanced Liver Disease**

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**Background:** Patients (pts) with advanced liver disease (ALD) often have significant risk factors for coronary artery disease (CAD). Dobutamine stress echocardiography (DSE) has been used for identifying CAD, but often the rate pressure product (RPP) at peak stress in these pts is reduced due to profound vasodilation. Although this may reduce the sensitivity of wall motion analysis (WMA), perfusion imaging should still identify a significant stenosis in this setting. We hypothesized that real time perfusion (RTP) using intravenous (IV) ultrasound contrast would improve the detection of occult CAD in pts with ALD.

**Methods:** Over a four year period, we studied 268 pts (56±7 years, 162 men) with ALD who underwent RTP during DSE, and 268 selected pts without ALD (55±10 years, 146 men) who underwent conventional DSE without contrast for other indications. Both groups were matched for age, sex, and risk factors for CAD. Perfusion images in ALD pts were obtained following IV injections of Definity (n=62) or Optison (n=206), using low-mechanical index RTP.

**Results:** Among pts with ALD, 73 required orthotopic liver transplantation (OLT). RPP was significantly lower in ALD pts, especially those requiring OLT (Table). A total of 28 (10%) pts with ALD had abnormal RTP, while WMA was abnormal in only 8 (3%) ALD pts. All 7 pts that had >50% diameter stenoses confirmed at quantitative angiography had inducible perfusion defects, but only 1 had abnormal WMA.

**Conclusion:** RTP improves the detection of CAD during DSE in pts with ALD.

\*p<0.05 compared to pts without ALD

Stages	Variables	Pts without ALD (n = 268)	ALD Pts (n = 268)	OLT (n=73)
Baseline	Heart rate (bpm)	75±14	75±13	74±12
	Systolic blood pressure (mm Hg)	134±19	127±23*	123±21*
	RPP (mm Hg/min)	10,032±2,228	9,579±2,371*	9,189±2,189*
Peak	Heart rate (bpm)	149±12	147±11	147±8
	Systolic blood pressure (mm Hg)	135±33	127±33*	120±31*
	RPP (mm Hg/min)	20,066±5,314	18,607±5,086*	17,702±5,023*
	% Predicted maximal heart rate	90±8	90±6	89±5

**1139-85 Value Of Combined Dobutamine Stress Echocardiography And Myocardial Contrast Echocardiography In Determining Prognosis Of Patients With Known Or Suspected Coronary Artery Disease**

Costandina Aggeli, George Rousakis, C. Kokkinakis, Stella Brilli, George Latsios, John Barbetseas, Christos Pitsavos, Christodoulos Stefanadis, University of Athens, Athens, Greece

**Purpose:** This study sought to determine whether the combination of dobutamine stress echocardiography (DSE) and myocardial contrast echo (MCE) can be used to predict morbidity and mortality in patients with known or suspected coronary artery disease.

**Methods:** Follow-up was performed on 230 patients (mean age: 63 y, 188 men) over a period of 36 months (an average 25 months) after clinically indicated DSE. The



DSEMCE protocol included SonoVue (Bracco) infusion (at a rate of 0.8 ml/min) during the baseline echo study and during the last stage of DSE using power modulation and a low mechanical index (0.1-0.2). Transient high mechanical index (1.7) pulses were used to destroy microbubbles, allowing the assessment of myocardial replenishment. All echo studies were stratified according to either inducible wall motion abnormalities or MCE perfusion defects into 4 responses: negative for ischemia DSE(-) and MCE(-), positive DSE(+) and negative MCE(-), negative DSE(-) and positive MCE(+) as well as positive DSE(+) and MCE(+). The combined end points of cardiac death and/or events were tabulated for the outcome.

**Results:** Cardiac events occurred in 43 patients (19%). A negative DSE(-)MCE(-) was associated with a statistically lower likelihood of cardiac event compared to other DSEMCE responses ( $p=0.003$ ). The combination of both positive DSE(+)MCE(+) was associated with a higher likelihood of cardiac events by the multivariate analysis ( $p=0.01$ ). By multiple logistic regression analysis of DSE-MCE response, age, and cardiac risk factors, a positive DSE and/or MCE response was independently associated with the occurrence of a cardiac end point during the follow-up period. In a multivariate Cox proportional hazards model, the likelihood of any cardiac event was increased in the presence of both positive DSE-MCE response (relative risk [RR] 6.8, 95% confidence interval [CI] 4.09 to 10.4,  $p<0.01$ ).

**Conclusions:** The presence of positive response during DSE-MCE is an independent predictor of cardiac events and therefore it can identify high and low risk subsets of patients with known or suspected coronary artery disease. Long term follow up of these patients would merit major consideration.

1139-86

### Combination Of Myocardial Contrast Echocardiography And Dobutamine Stress Echo In Predicting Myocardial Recovery After Revascularization In Patients With Occluded Coronary Artery Disease

Costandina Aggeli, George Rousakis, Stratis Tapanlis, Christos Kokkinakis, George Latsios, Stella Brill, Christos Pitsavos, Christodoulos Stefanadis, University of Athens, Athens, Greece

**Purpose:** The aim of this study was to compare the ability of myocardial contrast echocardiography (MCE) and dobutamine stress echocardiography (DSE) to predict recovery of dysfunctional myocardium after revascularization in patients with one occluded coronary artery.

**Methods:** 41 patients (mean age  $62\pm 4$  y) with LAD disease, 23 with severe stenosis  $>70\%$  (group A) and 18 with occluded LAD (group B) and regional dysfunction underwent MCE and DSE 2-5 days before revascularization. MCE was performed using real-time low mechanical index power modulation imaging during continuous infusion of SonoVue (Bracco). Contrast opacification assessed at 10 cardiac cycles after bubble destruction by high acoustic power and contrast score index (3 grade scale) for the LAD supplied area was calculated. All patients underwent coronary bypass grafting and follow-up low dose dobutamine was repeated 2-3 months after revascularization.

**Results:** There were no differences in age, ejection fraction at rest, and wall motion score index at rest between the two groups. Of 243 dysfunctional segments in the LAD territory undergoing revascularization 109 (62 in group A and 47 in group B) recovered at followup. In group A, MCE and DSE exhibited similar values of sensitivity, specificity and accuracy (87% vs. 87%, 62% vs. 72%, 73% vs. 79%, respectively) whereas in group B, MCE showed higher sensitivity and negative predictive value than DSE (81% vs. 57%,  $p<0.001$  and 80% vs. 68%,  $p<0.05$ , respectively) in predicting segmental myocardial recovery. These differences in sensitivity and negative predictive value between MCE and DSE were more pronounced in akinetic segments of group B (75% vs. 35%,  $p<0.001$  and 75% vs. 56%,  $p<0.05$ ). Significant correlation was observed between the regional contrast score index and both the follow up regional wall motion score index ( $r=-0.65$  for group A and  $r=-0.60$  for group B) and the follow up ejection fraction change ( $r=0.64$  for group A and  $r=0.60$  for group B).

**Conclusions:** MCE demonstrates higher sensitivity and negative predictive value compared with DSE in predicting recovery of dysfunctional myocardium supplied by totally occluded LAD after revascularization.

## POSTER SESSION

### 1140 Computed Tomography for Disease Progression: Atherosclerotic Plaque

Tuesday, March 08, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 10:00 a.m.-11:00 a.m.

1140-71

### Characterization of Noncalcified Coronary Atherosclerotic Plaque by Multidetector Row CT: Comparison to IVUS

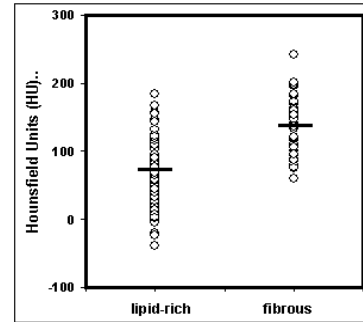
Stephan Achenbach, Dieter Ropers, Karsten Pohle, Udo Hoffmann, Maros Ferencik, Fabian Moselewski, Ray Chan, Thomas J. Brady, Ik-kyung Jang, Werner G. Daniel, University of Erlangen, Erlangen, Germany, Massachusetts General Hospital, Boston, MA

Multi-detector row CT (MDCT) permits visualization of the coronary arteries and, under favourable conditions, detection of atherosclerotic plaque. We investigated the CT attenuation of non-calcified plaques in comparison to their characterization by intravascular ultrasound (IVUS).

**Methods:** 30 patients were investigated by 16-slice CT (370 or 420 ms rotation time, 0.75 mm collimation, 80 ml contrast agent i.v.) IVUS of one coronary artery was performed (LM+LAD: 21, LM+LCX: 4, LM+RCA: 5). At 238 sites within the coronary system, in which non-calcified atherosclerotic plaque could be identified both in MDCT and IVUS, the CT attenuation within the plaque was measured. The measured CT attenuation values were correlated to the appearance of the plaque in IVUS (hyperechoic in comparison to adventitia = fibrous, hypoechoic = lipid-rich).

**Results:** The mean CT attenuation within fibrous plaques was  $127\pm 42$  HU ( $n=69$ ). The mean CT attenuation within lipid-rich plaques was  $59\pm 43$  HU ( $n=169$ ,  $p<0.001$ ). However, there was substantial overlap of the density values measured in fibrous and lipid-rich coronary plaques (see graph).

**Summary:** While a significant difference of the mean CT attenuation within fibrous and lipid-rich coronary atherosclerotic plaques could be observed, the substantial overlap of attenuation values casts doubts on the ability of MDCT to accurately characterize composition of single coronary plaques.



1140-72

### Direct Non-invasive Detection of Coronary Remodeling Using Multi-detector CT

Edward P. Shapiro, Pamela Ouyang, Joao A.C. Lima, Julie M. Miller, Marco A. Cordeiro, Irfan S. Shafique, David E. Bush, Johns Hopkins Medical Institutions, Baltimore, MD

**Introduction:** The ability to detect coronary remodeling using non-invasive methods would have important implications for identifying and treating the vulnerable patient (pt). Calcium scores provide a measure of arterial disease, but lack sensitivity in younger individuals, and cannot identify soft plaque, the proximate cause of coronary events.

**Hypothesis:** We used multi-detector CT (MDCT) to measure the area and density of the coronary wall (including plaque) and lumen, to test the concept that differences in vessel wall characteristics in pts with and without known CAD, can be detected non-invasively.

**Methods:** Pts admitted with chest pain of uncertain etiology underwent MDCT using a 16 slice Toshiba scanner with 400 ms rotation time, acquiring 0.5 or 1 mm thick slices. Coronary wall area (calcified and non-calcified), and lumen area were measured every 4 mm in the left main and along the first 40 mm of the three major coronary arteries using software designed to distinguish arterial components, guided by pre-specified ranges of Hounsfield units. Vessel characteristics in pts with clinical CAD by history or in-hospital testing vs. those without, were compared.

**Results:** Twenty-six pts (77% male) aged  $55.9\pm 10$  years, were studied. Thirteen (50%) were found to have CAD. The average coronary lumen area was similar in pts with CAD compared to those without ( $8.4\pm 4$  vs.  $9.2\pm 4$  mm<sup>2</sup>,  $p=NS$ ). However, the average ratio of non-calcified vessel wall area to luminal area (wall/lumen) along the 3 major arteries was greater in pts with CAD than those without ( $1.5\pm 0.5$  vs.  $1.1\pm 0.2$ ,  $p=0.009$ ), reflecting coronary remodeling. Total wall/lumen including calcified wall components, was also greater in CAD vs. without ( $1.7\pm 0.6$  vs.  $1.1\pm 0.2$ ,  $p=0.003$ ). The average Hounsfield unit of the arterial wall ( $83\pm 13$  vs.  $81\pm 16$ ,  $p=NS$ ) was not different in the two groups, nor was the area of the wall occupied by calcium ( $1.7\pm 2$  vs.  $0.5\pm 1$  mm<sup>2</sup>,  $p=NS$ ).

**Conclusion:** The average ratio of wall area to lumen area in the proximal coronaries, a gauge of coronary remodeling, is significantly increased in pts with CAD. This MDCT measurement of coronary geometry may provide the first practical non-invasive measure of total coronary artery disease burden.

1140-73

### Non-invasive Imaging of Coronary Artery Plaque Rupture: Multi-slice Computed Tomographic Angiographic Visualization in an Ambulatory Patient Population

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**Background:** Coronary artery plaque rupture is a potentially lethal complication of atherosclerosis. No known diagnostic modality, invasive or non-invasive, is known to detect its occurrence. Multi-slice Computed Tomographic Angiography (MSCTA) provides detailed information not only about stenosis severity, but also about the vessel wall and plaque character, potentially enabling non-invasive plaque characterization. We thus evaluated MSCTA as a non-invasive method for imaging coronary plaque rupture in ambulatory patients.

**Methods:** One hundred, seventy-six (176) consecutive patients were scanned for clinical indications (chest pain, elevated risk factors) using a Siemens Sensation 16 MSCT scanner. They received intravenous contrast injection and beta blockade, if needed, to achieve a heart rate of 65 bpm or less (mean = 56). Scans were reviewed for lesions containing contrast penetrate into the coronary artery wall and surrounded by plaque, consistent with plaque rupture.

**Results:** A ruptured coronary artery plaque was found in 22% of cases (39/176). Statistically significant differences in patient groups with and without ruptured coronary artery plaque were triglyceride level (230 vs. 149 mg/dL) and Calcium Score (352 vs 147) respectively. In 39 patients with ruptured plaque, only 61% (24/39) had severe stenosis in any vessel.

**Conclusions:** 1) Ruptured plaque appears detectable noninvasively by MSCTA. 2) It is remarkably prevalent in patients presenting with clinical indications. 3) Patients with ruptured plaque had significantly higher triglyceride levels and calcium scores. 4) Ruptured plaque may be associated chest pain in a substantial fraction of patients who do not have significant stenosis.

#### 1140-74 Quantitative Assessment of Coronary Arteries by Multislice Computed Tomography

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**Background:** The establishment of the standard method for the quantitative measurement of multislice CT (MSCT) is of paramount importance for its clinical use. We evaluated the accuracy of quantitative assessment of MSCT images with the use of the full-width-half-maximum method (FWHM), and assessed if this method would be affected by plaque volume, vessel size, or CT density of coronary arteries.

**Methods:** A total of 78 coronary segments from 48 patients were assessed by both MSCT and intravascular ultrasound (IVUS). MSCT cross-sectional images were obtained using 16-slice MSCT, and lumen area (LA) was measured by digital caliper with FWHM. LA determined by IVUS was used for the standard of reference, and compared with MSCT measurements. All 78 segments were divided into each two groups by the medians of three parameters (% plaque area; GP: >40% or SP: ≤40%, lumen area; GA: >8.58mm<sup>2</sup> or SA: ≤8.58mm<sup>2</sup>, maximum CT density in the lumen; HD: > 320HU or LD: ≤ 320HU), then we evaluated the correlation between IVUS and MSCT measurements in each groups and performed a Bland-Altman analysis to assess if any of the parameters affected the agreement. In tight stenosis group with lumen area less than 4.0mm<sup>2</sup> (N=14), we separately analyzed the concordance between IVUS and MSCT measurements.

**Results:** In all segments, linear regression analysis revealed a tight correlation between MSCT derived LA and IVUS derived LA (r<sup>2</sup>=0.91). In each group, good correlation and agreement between MSCT and IVUS measurements were also observed. No significant difference in agreement was observed between GP and SP, or between HD and LD. However, weaker correlation and agreement were observed between MSCT and IVUS in SA compared with in GA, (r<sup>2</sup>=0.631, and r<sup>2</sup>=0.783, respectively). In tight stenosis group, we found no significant correlation between MSCT and IVUS measurements (r<sup>2</sup>=0.07).

**Conclusions:** Quantitative measurements of MSCT images using the full-width-half-maximum method showed good agreement with IVUS measurements irrespective of plaque volume or CT density. In stenotic segments, however, MSCT measurements using FWHM method may not be applicable.

#### 1140-75 Multislice CT Predictors of Restenosis After Stent Implantation

Tomoyuki Umemoto, Tsunekazu Kakuta, Shigeki Kimura, Osamu Kuboyama, Taishi Yonetsu, Hidenori Fujiwara, Mitsuaki Isobe, Tsuchiura Kyodo General Hospital, Tsuchiura, Japan, Tokyo Medical & Dental University, Tokyo, Japan

**Background:** We sought to assess whether multislice CT (MSCT) performed before PCI has the predictive value of restenosis.

**Methods:** A total of 61 lesions of 53 patients with angiographically significant coronary artery disease, in whom pre-PCI 16-slice MSCT with evaluable image quality was obtained, were evaluated. For MSCT image analysis, MIP, VR, MPR, and cross-sectional images were assessed for reference diameter (RD, mm), lesion length (LL, mm), minimum lesion diameter (MLD, mm), lesion eccentricity, positive or negative remodeling, and mean CT density of plaque determined by ROI methods (CT, HU). Mean CT density was determined by calculating the mean of CT densities obtained from 5 randomly chosen ROIs inside the plaque. Follow-up conventional coronary angiography was performed at 6 - 9 months after PCI in all patients, and restenosis was defined by ≥ 50% angiographic diameter reduction. Each parameter was compared between restenotic and non-restenotic lesions.

**Results:** Stent implantation was performed in 53 lesions. Restenosis occurred in 14 lesions (26.4%). RD, LL, and CT were significantly different between restenotic and non-restenotic lesions (2.7 ± 0.7mm vs 3.1 ± 0.6 mm, 11.3 ± 3.6mm vs 7.5 ± 3.8mm; 118 ± 39 vs 68 ± 40 HU, respectively, p<0.05).

**Conclusion:** RD, LL, and CT obtained in preprocedural MSCT may predict restenosis after PCI. MSCT before PCI may help tailoring therapeutic approach including the choice of drug eluting stent or CABG.

#### 1140-76 Multislice Cardiac Computer Tomography is Useful in The Detection of Coronary Artery Disease in Patients With Positive Cardiac Family History

Bharati Shivalkar, Rodrigo Salgado, Ozkan Oszcharlak, Inge Goovaerts, Bernard Paelinck, Paul Parizel, Christiaan Vrints, University Hospital Antwerp, Edegem, Belgium

**Background:** The presence and extent of coronary artery calcification is indicative of total burden of calcified and noncalcified plaque, and may detect potentially vulnerable lesions. We hypothesize that multislice cardiac computer tomography (MSCT) may be useful to assess coronary artery disease (CAD) in asymptomatic individuals with a low Framingham risk score (FRS) and positive family history (PFH) for cardiac disease.

**Methods:** One hundred and fortyeight asymptomatic patients including 47 with PFH (male/female, age 56±12 years) with low to intermediate FRS had a MSCT (Siemens, 16-rows) for coronary artery calcium scoring (CACS, Agatston score) and CT angiography (CTA), as well as a stress MIBI, carotid intima media thickness measurement (IMT), and biochemical analysis (lipid, fibrinogen levels, C-reactive protein). The coronary arteries

were divided into 12 segments similar to conventional coronary angiography (CA) for grading of luminal stenosis. Data are given as mean ±SD.

**Results:** Ninetytwo of the 148 patients had a positive CACS (241±527), of whom 34 had a PFH (CACS:251±593). Significant correlation was found between CACS and age, IMT, systolic blood pressure and total cholesterol (p<0.05). In the subgroup with PFH stepwise regression analysis showed that increased IMT predicted likelihood of CACS (p= 0.01). In 40 patients with either a significant CACS (>400) or evidence of soft plaque and a >50% stenosis on CTA, and or abnormal stress-MIBI, CTA was performed. High CACS predicted likelihood of at least one significant coronary stenosis on CA (p=0.01). The overall agreement for 454 coronary segments between CTA and CA was 88%, with a very good concordance (kappa = 0.62). The concordance between stress MIBI and CA was moderate at kappa = 0.44, whereas the agreement between CA and the combined stress MIBI-CTA findings was excellent at 93% (kappa =0.69). The negative predictive value of the assessable segments with CTA was excellent at 95%, with a positive predictive value of 65%.

**Conclusions:** In patients with a low FRS but PFH a strong association was found between CACS and IMT. MSCT is useful in the detection of CAD in patients with PFH and reliably selects patients for further invasive assessment.

#### 1140-77 Reliability of Comprehensive Analysis of Coronary Vessel and Plaque in Patients with Acute Coronary Syndrome by Multi-detector row CT with "Plaque Map" System

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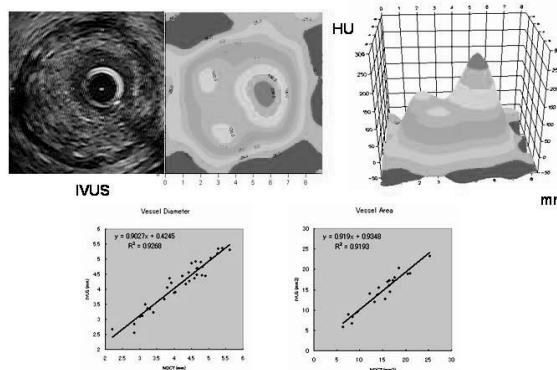
**Background:** We examined the reliability of comprehensive analysis method "Plaque Map" System for any MDCT images.

**Methods:** 102 consecutive ACS patients from March 2003 to August 2004 were enrolled (F.M= 12:90; 67±11 yrs). 16-detector MDCT was done after 2wks after PCI. Coronary vessel diameter/area, plaque, and positive/negative remodeling by "Plaque Map" images were analyzed and compared with IVUS and angiography. Stent patency of MDCT was examined at six month after PCI, comparing follow-up coronary angiography in 28 patients.

**Results:** Vessel diameter/area measured by "Plaque Map" were correlated with IVUS (r<sup>2</sup>=0.93 and r<sup>2</sup>=0.92, respectively). Stent size was 3.0±0.4 mm and stent length was 16.2±5.5 mm (mean±SD) in chronic stage. Stent occlusion was detected by "Plaque Map" pattern when the diameter of stent was 3.0 mm or more. In 11 patients stents were occluded and corresponded with coronary angiogram. The sensitivity and specificity of stent patency detected by "Plaque Map" compared with coronary angiogram were 88 % and 84%, respectively. Coronary positive/negative remodeling were analyzed by "Remodeling Map", that was modified "Plaque Map" focused on remodeling. The sensitivity and specificity of positive/negative remodeling were 84% and 83 %. The sensitivity and specificity of detection of soft plaque by MDCT compared with yellow plaque by angiography were 77 % and 90 %.

**Conclusion:** "Plaque Map" System for MDCT may analyze precisely and have a role for risk stratification of vulnerable patients.

#### Coronary "Plaque Map"



#### 1140-78 Delayed-Contrast Vessel Wall Enhancement of Coronary Atherosclerotic Plaques: An Ex-vivo Multi-Detector Computed Tomography Study

Paul Schoenhagen, Sandra Halliburton, Anuja Nair, Arthur Stillman, Michael Lieber, Geoffrey Vinco, Murat Tuzcu, Richard White, Cleveland Clinic Foundation, Cleveland, OH

**Background:** MDCT studies have described characterization of atherosclerotic lesions based on Hounsfield number (HU). However, the influence of contrast-enhancement of the vessel wall and plaque is unknown.

**Methods:** Six human coronary arteries were examined post-mortem with MDCT (16 slice/rot, 420 ms rot time, 0.6 mm slice) and IVUS during continuous saline perfusion. MDCT was performed before, during, and after (10-20 min) contrast injection. Eighteen focal atherosclerotic lesion sites were identified and matched to IVUS. Based on IVUS, plaques were identified as homogeneous (predominantly fibrous or predominantly soft) or mixed (calcified/fibrous or calcified/soft). Using MDCT, multiple ROIs were defined in the vessel wall and the mean HU of plaque burden was measured during all contrast phases.

A one-way analysis of variance was performed within each plaque group, comparing mean HU among the three groups.

**Results:** Contrast enhancement for homogeneous plaques, showed significant differences relative to the contrast phase ( $p=0.005$ ). The differences in contrast enhancement were not significant for mixed plaques. (Table)

**Conclusion:** The results demonstrate significant contrast vessel wall enhancement of coronary atherosclerotic plaques depending on predominant morphology. The contrast-enhancement profile is likely a result of diffusion of iodine into the vessel wall or filling via the vasa vasorum and should be considered in the characterization of plaques with contrast-enhanced MDCT.

Hounsfield Number of Atherosclerotic Plaques.

Plaques	HU - Pre-Contrast	HU - Contrast	HU - Post-Contrast
Homogeneous (N=9)	9 ± 30*	61 ± 43*	46 ± 11*
Mixed (N=9)	74 ± 89	141 ± 141	132 ± 150

POSTER SESSION

**1141 Magnetic Resonance Imaging of Atherosclerosis, Thrombosis, and New Techniques**

Tuesday, March 08, 2005, 9:00 a.m.-12:30 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 10:00 a.m.-11:00 a.m.

**1141-63 Early versus Advanced Atherosclerotic Plaque in vivo Detection by Gadofluorine-Enhanced Magnetic Resonance Imaging**

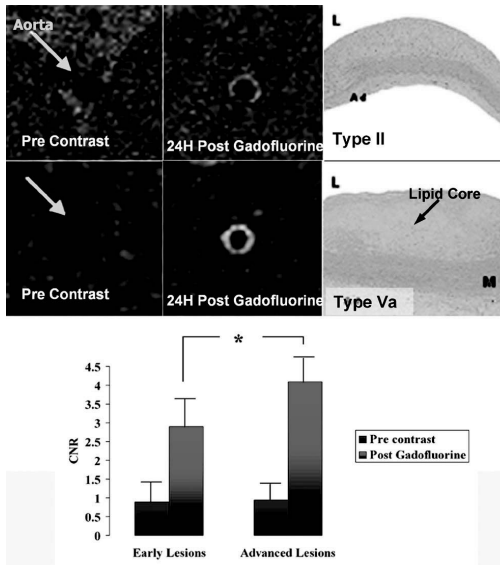
Marc Sirol, Pedro Moreno, Valentin Fuster, Hanns Joachim Weinmann, Jean-Francois Toussaint, Zahi A. Fayad, Mount Sinai School of Medicine, New York

**Background:** Our group has recently reported the use of Gadofluorine-enhanced MRI for detection of lipid-rich plaques. Detection of subclinical atherosclerosis such as early lesions could improve diagnostic and guidance of therapy. We sought to evaluate the use of Gadofluorine for the assessment of early and advanced atherosclerotic plaques.

**Methods:** Aortic denudation was performed in 16 rabbits fed with 0.2% cholesterol diet (HC) for either 2 months (early plaque group (Ea)) or for 8 months (advanced group (Ad)). Six animals were used as control (no HC). MRI was performed before and 24 hours after Gadofluorine (Schering AG) injection using T1w, T2w and PDw imaging.

**Results:** Plaque enhancement was successful after injection in both Ea and Ad group (Figure 1). Contrast-to-noise ratio (CNR) was significantly higher in Ad group compared to Ea group ( $P<0.01$ ). No enhancement was seen in controls. AHA classification revealed type II and III plaque in Ea group, and type Va and Vc plaque in Ad group ( $P<0.001$ ). Pre-contrast MRI using multicontrast technique was not able to identify atherosclerotic plaques in the Ea group compared to the Ad group ( $P<0.001$ ).

**Conclusions:** We demonstrate the successful use of Gadofluorine for early plaque detection compared to non-contrast enhanced MRI. Early lesions could be differentiated from advanced plaque according to CNR values after Gadofluorine injection. This approach may be useful in the assessment of atherosclerotic burden in patients at different stages of the disease.



1141-64

**Detection of Acute and Chronic Arterial Thrombi in vivo: A comparative Study of non-Contrast Enhanced Magnetic Resonance Imaging (MRI) and Fibrin-Targeted Contrast Enhancing MR Agent**

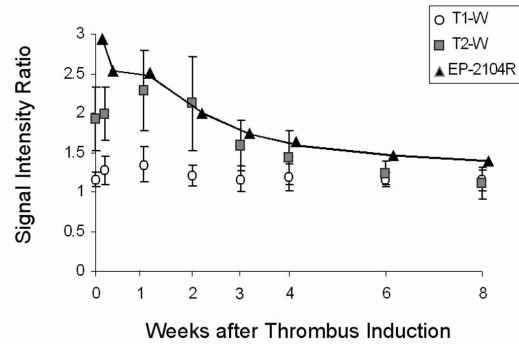
Marc Sirol, Valentin Fuster, Juan J. Badimon, Juan Viles-Gonzalez, John T. Fallon, Zahi A. Fayad, Mount Sinai School of Medicine, New York, NY

**Background:** Arterial thrombosis plays a critical role in clinical manifestation of cardiovascular diseases. Thrombus detection by MRI has been successfully reported using either non-contrast enhanced MRI (CE-MRI) or targeted contrast agents. However, no study has compared the two techniques for arterial thrombus detection. Therefore, we sought to compare to non CE-MRI the use of a fibrin-targeted MR contrast agent in a model of acute and chronic thrombosis.

**Methods:** Carotid arteries were injured in 14 NZW rabbits. High-resolution multicontrast MRI (T1W, T2W, PDW) was performed followed by T1W images after EP-2104R (Epic Medical Inc.) injection. Images were acquired immediately, 48 hours and every week up to 8 weeks after carotid injury.

**Results:** Thrombus appearance and relative signal intensity (SI = SI thrombus / SI Muscle) revealed characteristic temporal changes in non CE-MRI. Acute thrombi appeared very bright on T2W images (SI = 2.27 ± .51 at 1 week). After EP-2104R injection, thrombus enhancement was achieved in all cases. SI was greatly increased in acute ( $P<0.0001$ ) and in chronic thrombi ( $P<0.001$ ). SI was significantly higher ( $P<0.01$ ) after injection even 6 weeks after thrombus formation compared to non-CE-MRI (Figure 1).

**Conclusion:** We demonstrate the feasibility and the superiority of fibrin-targeted MR contrast agent for acute and chronic thrombus detection in vivo compared to non CE-MRI. MR contrast-enhancement was highest for acute thrombi and decreased in chronic organizing thrombi.



1141-65

**HDL<sub>3</sub> Is Independently Related to Lipid Core Volume in Atherosclerotic Plaques Measured by High Resolution MRI**

Milind Y. Desai, Annabelle Rodriguez, Gary Gerstenblith, Sachin Agarwal, Margene Kennedy, David A. Bluemke, Joao AC Lima, Johns Hopkins University, Baltimore, MD

**Background:** High density cholesterol (HDL) is known to have a cardio-protective role believed to be primarily mediated by reverse cholesterol transport. However, HDL is a heterogeneous molecule with 2 major sub-fractions: HDL<sub>2</sub> (large buoyant) and HDL<sub>3</sub> (small dense) and controversy exists regarding the protective role of HDL<sub>2</sub> or HDL<sub>3</sub> in atherosclerosis. **Aim:** To determine the relationship of HDL<sub>2</sub> and HDL<sub>3</sub> with lipid core (LC) volume measured in the atherosclerotic plaque (AP) of the internal carotid artery (ICA) imaged using magnetic resonance (MR) imaging.

**Methods:** ICA's of 28 patients with known atherosclerosis (mean age 73 ± 4 years, 73% males) were imaged on a 1.5 T CV/i GE MR scanner. Five oblique slices each of the ICA in 3 different weightings: T1-weighted and T2-weighted (both pre-contrast) and T1-weighted (after infusion of 0.1 mmol/kg of intravenous gadodiamide) were obtained and composite volume of LC was calculated using MASS software (MEDIS, Netherlands). HDL<sub>2</sub> and HDL<sub>3</sub> were calculated from plasma by ultracentrifugation using the vertical auto profile (VAP) technique (Atherotech, Inc, Alabama). Cardiac risk factors, low density cholesterol (LDL), triglycerides (TG) and abdominal girth were recorded.

**Results:** The mean total HDL, HDL<sub>2</sub> and HDL<sub>3</sub> were 48 ± 11, 11 ± 5 and 36 ± 7 mg/dl, respectively. The mean LC volume in AP was 0.03 ± 0.03 mm<sup>3</sup>. On linear regression, there was an inverse correlation between LC and HDL<sub>3</sub> ( $r = -0.57$ ,  $p = 0.003$ ) which remained significant after addition of the following confounding variables in a multivariate model: diabetes, gender and abdominal girth ( $R^2 = 70\%$ ,  $R^2$  adjusted = 63%,  $p < 0.001$ ). For HDL<sub>2</sub>, a trend towards significance ( $r = 0.35$ ,  $p = 0.08$ ) became non-significant after multiple regression analysis ( $R^2 = 60\%$ ,  $R^2$  adjusted = 21%,  $p = 0.27$ ).

**Conclusion:** Plasma HDL<sub>3</sub> is inversely correlated to lipid core size in carotid atherosclerotic plaques of patients with advanced atherosclerosis. These results might provide support to the potential role of HDL<sub>3</sub> in reverse cholesterol transport and suggest that HDL sub-fraction analysis may add value to blood lipid assessment in patients with atherosclerosis.

### 1141-66 Age and Smoking, but Not Sex nor Ethnicity, Are Major Predictors of Abdominal Aortic Atherosclerosis: Results From the Dallas Heart Study

Hao S. Lo, Roderick McColl, Mujeeb Basit, DuWayne Willett, Ronald M. Peshock, University of Texas Southwestern Medical Center, Dallas, TX, Donald W Reynolds Cardiovascular Clinical Research Center, Dallas, TX

**Background:** Atherosclerotic cardiovascular disease is the major cause of morbidity and mortality in the United States. We used magnetic resonance imaging (MRI) to evaluate the prevalence and extent of abdominal aortic atherosclerosis as a marker for subclinical atherosclerotic disease in the participants of the Dallas Heart Study (DHS), a prospective population-based cohort reflecting the ethnic composition of Dallas County, Texas.

**Methods:** High-resolution imaging of the abdominal aorta at 1.5T using a gated, fat-suppressed, double-inversion recovery, T2-weighted sequence was performed in 2,515 participants. The vessel wall was defined. Areas of hyper-intense signal and luminal protrusion were used to determine plaque presence and total aortic plaque area.

**Results:** The cohort (age 44.3±9.9, 54.8% female) showed an overall prevalence of atherosclerosis by MRI of 38.9%. Age and smoking were strong independent predictors (both  $p < 0.01$ ) of the presence of aortic plaque in a logistic regression model. Each 10-year increase in age was associated with a factor of 1.96 (95% CI 1.77, 2.18) increase in odds of aortic plaque. Smoking was associated with a 2.40 (95% CI 1.95, 2.96) increase in odds. Diabetes and systolic blood pressure (both  $p < 0.01$ ) were also positive predictors while high-density lipoprotein and body mass index (both  $p < 0.01$ ) were weak negative predictors. Sex and ethnicity were not significant predictors of aortic plaque presence. Aortic plaque extent also increased with age and was associated with the same risk factors.

**Conclusions:** Sub-clinical atherosclerosis, as detected by MRI, is present in a high percentage (38.9%) of participants in a large, multiethnic population-based sample. In this cross-sectional study, the prevalence of atherosclerosis is strongly linked to age and smoking but not sex nor ethnicity.

### 1141-67 In Vitro Quantification of Cells Labeled with Magnetic Nanoparticles Using Off-resonance Sequence

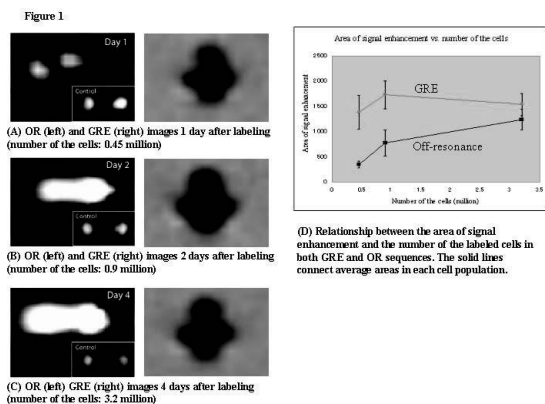
Takayasu Arai, Charles H. Cunningham, Michael V. McConnell, Steven M. Conolly, Phillip C. Yang, Stanford University, School of Medicine, Stanford, CA

**Introduction.** *In vivo* monitoring of cell-based therapy is not available clinically. In order to address this issue, we developed off-resonance (OR) magnetic resonance (MR) pulse sequence, which exploits the magnetic dipole gradient to generate positive contrast from super-paramagnetic iron oxide (SPIO) labeled mouse embryonic stem cells (mESC). Feasibility of the OR sequence to quantify the SPIO-labeled mESC *in vitro* was tested.

**Methods.** Cell labeling solution was prepared by incubating 250µg/ml of ferumoxides (Feridex®, Berlex Laboratories) with 1µg/ml of poly-L-lysine for 60minutes. Approximately  $5 \times 10^5$  mESC were incubated with the labeling solution for 24 hours. The labeling solution was removed and 4 samples of the labeled mESC were allowed to divide for 4 days. Cells were counted using a hemocytometer. At days 1, 2, and 4, mESC were suspended in four vials filled with 0.9% saline and were inserted into agar gel for susceptibility matching. GRE (100ms TR, 7.2ms TE, 30°flip angle) and OR imaging (200ms TR, 14ms TE) were performed using a conventional 1.5T Signa MR Scanner (GE, Milwaukee, WI). Signal area was measured by computing the number of pixels 5 standard deviations above the mean noise magnitude.

**Results.** This study shows monotonic relationship between signal area and labeled cell population using OR ( $r=0.855$ ), however, not with GRE ( $r=0.037$ ).

**Conclusion.** The data suggests that OR quantifies the proliferating labeled cell population. This technique may enable *in vivo* cell quantification.



### 1141-68 Magnetic Resonance Coronary Angiography with a Fluorinated Nanoparticle Contrast Agent

Anne M. Morawski, Shelton D. Caruthers, Franklin D. Hockett, Ralph W. Fuhrhop, Gregory M. Lanza, Samuel A. Wickline, Washington University School of Medicine, St. Louis, MO, Philips Medical Systems, Best, The Netherlands

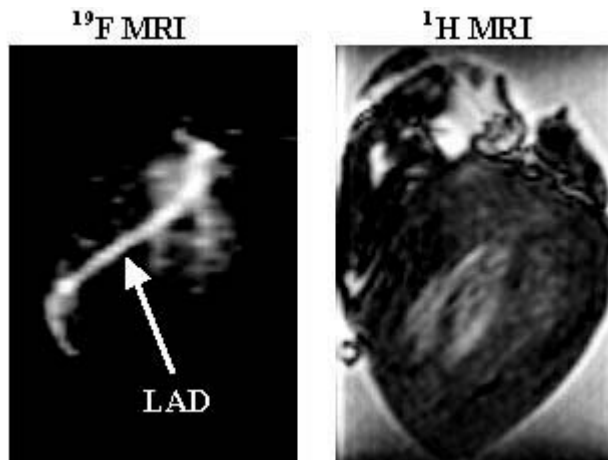
**Background:** We have developed a  $^{19}\text{F}$ -based intravascular contrast agent that promises to improve coronary imaging by allowing spatially matched detection of two different MR signals,  $^{19}\text{F}$  and the standard  $^1\text{H}$ . This nanoparticle emulsion offers a unique spectral signature for visualizing coronary artery anatomy with no background signal.

**Methods:** A liquid perfluorocarbon (PFC) nanoparticle contrast agent (20% v/v perfluoro-15-crown-5-ether; diameter ~250 nm) was injected through a 2 F diameter

balloon catheter into the LAD coronary artery of an isolated pig heart. Balanced FFE  $^{19}\text{F}$  projection scans (TR= 4ms, TE= 1.5 ms, matrix=  $2 \times 2.5 \times 70$  mm) were acquired on a clinical 1.5 T Philips MR scanner outfitted with a special channel tuned for fluorine nuclei and a 13cm Helmholtz RF coil. Corresponding  $^1\text{H}$  MRI scans of the heart anatomy were used for localization of the  $^{19}\text{F}$  image signal.

**Results:** The figure below depicts the left coronary artery tree of this heart as seen with  $^{19}\text{F}$  MRI after injection of nanoparticles. This technique generated a signal to noise ratio of 19.7 from the vessel with a scan time of only 2.8 s per image. A series of dynamic images acquired during injection allowed visualization of vascular filling.

**Conclusions:** We have demonstrated a method for  $^{19}\text{F}$ -based coronary MR angiography that requires neither fat suppression nor other preparatory pulses using PFC nanoparticles. Ultimately, peripheral injections of nanoparticles may provide an improved method for noninvasive coronary MRA.



### 1141-69 Symptomatic Carotid Plaques Differ in MRI Signal but not in Size or Degree of Stenosis

Steffen Bohl, Ralf Wassmuth, Jeanette Schulz-Menger, Michael Gross, Matthias Friedrich, Franz Volhard Klinik, Berlin, Germany

**Methods:** We scanned 40 patients (48-83 years, 26 men) with carotid plaque in a 1.5 T MRI scanner with a bilateral phased array coil. A blinded neurologist independently classified 8 of the patients as symptomatic due to amaurosis fugax or a transient ischemic attack related to carotid stenosis. We acquired six to ten axial 3 mm slices starting in the common carotid artery just below the bifurcation with an in-plane resolution of 0.3 mm/pixel. Double inversion fast spin echo images were obtained in proton-density- and T2-weighting. Two independent readers measured plaque signal, contrast and volume. Results were compared to the degree of stenosis as determined by quantitative invasive angiography performed within 5+/-3 days.

**Results:** Symptomatic carotid plaques had a higher signal-to-noise ( $38 \pm 17$  vs.  $17 \pm 10$ ,  $p < 0.01$ ) and contrast-to-noise ratio ( $1.4 \pm 0.4$  vs.  $1.1 \pm 0.2$ ,  $p < 0.05$ ) in proton-density-weighted images than asymptomatic plaques. The mean signal did not differ in T2. Plaque volume was  $0.73 \pm 0.43$  cm with good interobserver agreement ( $r=0.75$ ). Symptomatic and asymptomatic patients did not differ in plaque size or angiographic degree of stenosis. Plaque volume by MRI did not correlate to the degree of stenosis by angiography.

**Conclusion:** Whereas carotid plaques in symptomatic patients do not differ from asymptomatic plaques in volume or angiographic degree of stenosis, they show a significantly higher signal in proton-density-weighted images. The MRI pattern might help to characterize plaques beyond traditional parameters with special respect to their prognostic relevance.

### 1141-70 Comparison of High-Resolution Three-Dimensional Aortic MR Angiography and Vessel Wall Imaging With Histology for Detection of Positive Arterial Remodeling (PAR) in a Rabbit Model

Henning Steen, Antonina Kolmakova, Subroto Chatterjee, Joao Augusto Lima, Matthias Stuber, Johns Hopkins University, Baltimore, MD

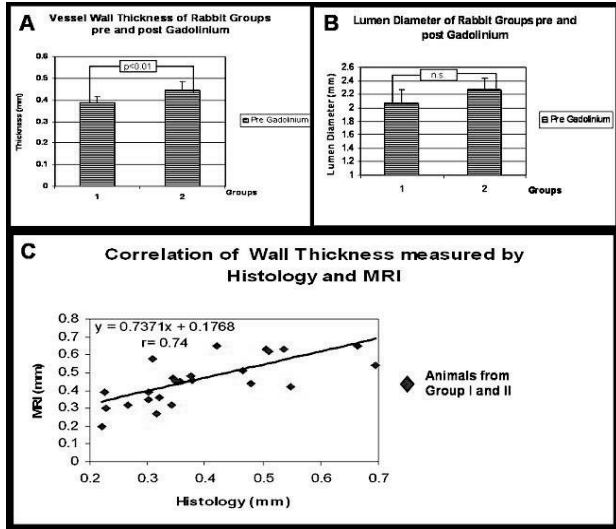
**Background:** Arterial lumen diameter changes and concomitant vessel wall thickening is referred to as PAR and is associated more frequently with acute coronary syndromes. We hypothesized that combined high resolution angiography and vessel wall MRI is an accurate *in vivo* measurement to detect sub-millimeter PAR in a Watanabe-(WT)-animal-model.

**Methods:** Multiple sub-renal 3D SSFP angiographies (TR=7.2ms, TE=3.6ms, resolution=0.7\*0.7\*1.5mm) and fat-sat 3D black blood Fast Spin Echo vessel wall images (TR=3RR, TE=10.5ms, in-plane resolution=250µm) were investigated in 40 slices of 8 WT (I=3normal, II=5with endothelial denudation+8 weeks high cholesterol-diet) on a 1.5T MR-system (Philips). Animals were sacrificed and matched MRI-histology wall/lumen dimensions were compared semi-automatically using a two-tailed paired Student's t-test.

**Results:** MRI angiography lumen diameters were similar in groups I ( $2.07 \pm 0.02 / 2.21 \pm 0.1$  mm) and II ( $2.26 \pm 0.17 / 2.22 \pm 0.19$  mm) and when compared to each other (Fig.B, all  $p = n.s.$ ). MRI wall thickness was similar in I ( $0.39 \pm 0.02$  mm) and II ( $0.44 \pm 0.04$ ) but significantly different when both groups were compared ( $0.39 \pm 0.02$  vs.  $0.44 \pm 0.04$  mm, Fig.A). Histology and MRI vessel wall dimension measurements were in good agreement ( $r=0.74$ , Fig.C).

**Discussion:** Non-invasive high resolution angiography and vessel wall imaging detects sub-millimeter PAR in an animal model on a commercially available 1.5T MRI system correlating well with histology.

10:45 a.m.



840-4

**Is Non-Doppler Based 2D Strain Rate Imaging Capable of Detecting Ascending and Descending Myocardial Muscle Band Motion? An In Vitro Model Study**

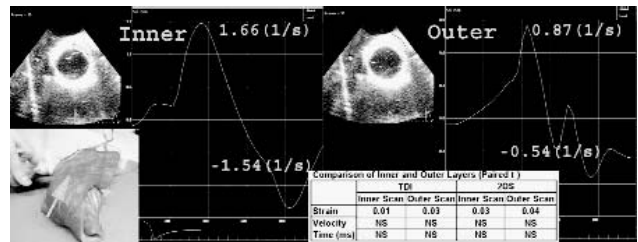
Virginia N. Corbett, Evan Pulvers, Xiaokui Li, Bo Ren, Fatima Ghani, Ruolan Liu, Kaeley Anderson, James Pemberton, David J. Sahn, Oregon Health & Science University, Portland, OR

**Background:** The role of the ascending and descending myocardial muscle bands in left ventricular motion is critical in heart function. 2D Strain (2DS) is a new method for assessing tissue motion. We attempted to verify this method's ability to differentiate the two muscle band movements during a heart cycle and compared it with the tissue velocity imaging (TDI) method.

**Methods:** We created 2 models using fresh sliced beef (0.5 cm and 0.25 cm thickness) wrapped around a latex balloon connected to a closed circuit pulsatile pump. The meat was layered at 60° to each other and sewed at one end around the balloon. Five stroke volumes (20- 60 ml/beat) were used at rates of 60 and 75 bpm. Scanning was performed using a GE/VingMed Vivid 7 (3.4 MHz) parallel to either inner or outer layers. Images were analyzed by both 2DS and EchoPac® TDI based strain software and correlated with sonomicrometry.

**Results:** SR derived by both methods showed a significant difference between the inner and outer layers (TDI: p = 0.01, 0.03; 2DS: p=0.03, 0.04). There was no significant difference in velocity between the outer and inner layers for both methods. TDI derived strain timing showed a difference between inner and outer peak expansions ranging from (20-80ms p = NS). The timing for 2DS was limited by software. 2DS measurements showed a moderate correlation with sonomicrometry determined deformation (r=.86, p=0.06).

**Conclusions:** 2DS is capable of evaluating tissue motion in different myocardial muscle bands in comparison with conventional TDI.



ORAL CONTRIBUTIONS

**840 Cardiovascular Ultrasound: Something New and Something Old But Yet New**

Tuesday, March 08, 2005, 10:30 a.m.-Noon  
Orange County Convention Center, Room 304A

10:30 a.m.

840-3

**Clinical Evaluation of a Novel Automatic Real-Time Myocardial Tracking and Wall Motion Scoring Algorithm for Echocardiography Introduction**

Alan S. Katz, Sriram Krishnan, Xiang Zhou, Bogdan Georgescu, Michael Gera, Dorin Comaniciu, Jinbo Bi, Glenn Fung, Jianming Liang, Bharat Rao, Roger Grimson, Nathaniel Reichel, Saint Francis Hospital, Roslyn, NY, Siemens Medical Solutions, Malvern, PA

**Background:** Accurate regional wall motion (WM) analysis of the left ventricle (LV) is an essential component of interpreting echocardiograms (echoes). Rapid and reliable automated border tracking coupled with computer WM scoring would be of great value. We present the results of a novel real-time automatic WM tracking and classification algorithm.

**Methods:** We developed a completely automated and robust technique to detect and track both the endocardial and epicardial borders of the LV. No human interaction is required. Motion interferences (probe motion, patient movement, respiration, etc.) are compensated using global motion estimation based on robust statistics outside the LV. The algorithm was trained using 142 randomly selected digital echoes. Only the apical four- and two-chamber views were analyzed. The septum, lateral, anterior and inferior walls were divided into three segments each. Numerical feature vectors extracted from the dual-contours tracked through time formed the basis for regional WM classification. Using machine-learning techniques, individual WM models were developed for each of the twelve LV segments analyzed and each segment was classified as normal (nl) or abnormal (abn).

The test set consisted of sixty digital echoes, which were not used in algorithm training. The twelve segments as described above were reviewed and classified by an experienced reader (AK) blinded to the computer results. The LV was classified as abn if there were two or more abn segments.

**Results:** Of the 41 echoes classified as abn by the observer, 34 were classified as abn by the computer. Of the 19 studies classified as nl by the reader, 15 were classified as nl by the computer. Sensitivity=83%; Specificity=79%

**Conclusions:** We present initial results of a novel real-time method of automated border tracking and wall motion scoring. The method is robust and was applicable to digital studies of varying quality with a high sensitivity and specificity. Evaluation is underway to assess the performance of the algorithm in classifying all LV segments.

840-5

**The Role of A Narrowed Lumen of The Transmural Small Coronary Artery on Regional Myocardial Ischemia in Patients With Hypertrophic Cardiomyopathy: Transthoracic Doppler Echocardiographic study vs. Thallium Scintigraphy Study**

Shinichi Minagoe, Yutaka Otsuji, Sadatoshi Biro, Shuichi Hamasaki, Koichi Kihara, Ryuichiro Anan, Toshinori Takenaka, Naoko Mizukami, Chuwa Tei, Kagoshima university, Postgraduate school of medicine, Kagoshima, Japan

Morphologic abnormalities of transmural small coronary arteries (SCA) are potential mechanism for ischemia in the absence of epicardial coronary artery stenosis in hypertrophic cardiomyopathy (HCM). We have previously reported that transthoracic Doppler echocardiography (TTDE) can detect a narrowed lumen of the SCA on the basis of the acceleration flow signal (Acl) within the SCA (500 to 1000 µm in diameter) in patients with HCM. To investigate the role of Acl in SCA for regional myocardial ischemia, we examined the presence or absence of Acl in the SCA using TTDE and compared it to results of exercise thallium-201 (Tl-201) SPECT in 33 patients with HCM (mean age 62 years) in whom epicardial coronary artery stenosis was neglected by coronary angiography. Acl signal within SCA was determined by setting the Niquist frequency to more than 45 cm/sec to exclude the aliasing with low velocity. Presence or absence of Acl signal was evaluated among 5 SCAs at the antero-septal area from the middle to the apex of the left ventricular wall and was compared to the corresponded area by thallium-201 SPECT. Exercise induced ischemia on SPECT was observed in 17 of 33 patients followed by a significantly high incidence of thickened ventricular septum more than 28 mm compared to other 16 patients without ischemia [9 of 17 (53%) vs. 1 of 16 (6%), p < 0.01]. Acl was observed in 17 of 33 (51%) patients with HCM and total number of Acl more than two (Acls) in the same or adjacent SCAs was ascribed to Group A; n=15) and no or only one Acl was assigned to Group B; n=18). Exercise induced ischemia on thallium-201 SPECT were significantly more frequent in group A compared with that in group B [11 of 17 (65%) vs. 4 of 12 (33%) respectively, p < 0.01]. There were no significant differences in the clinical characteristics, left ventricular size, its function, and serum brain natriuretic peptide between groups A and B.

**Conclusions:** 1. Narrowed lumen in the SCA demonstrated as Acls using TTDE would have an important role in determining the heterogeneity of myocardial ischemia in HCM. 2. Noninvasive measurement of the SCA flow using TTDE is a useful predictor of regional myocardial ischemia in the antero-septal area in patients with HCM.

11:00 a.m.

11:15 a.m.

840-6

### Echocardiographic and Biochemical Evidence of Ventricular Dysfunction Following Prolonged Strenuous Exercise

Tom G. Neilan, Malissa Wood, Danita Yoerger, Michael Picard, Arthur Siegel, Kent Lewandrowski, Elizabeth Lewandrowski, James Januzzi, Massachusetts General Hospital, Boston, MA

**Background:** Changes in echo indices of left ventricular function have been previously observed in marathon runners. These have not however been corroborated with changes in biochemical markers of ventricular dysfunction. **Methods:** Baseline TTE and venous blood testing was performed before and at the finish line of the Boston Marathon in 35 amateur runners. TTE included 2-D, spectral, tissue Doppler and peak ventricular systolic strain and strain rate. Venous blood samples included a highly specific marker of ventricular dysfunction, NT-proBNP (Elecys ProBNP (Roche Diagnostics, Indianapolis, IN)). **Results:** 85% of runners exhibited a significant increase in NT-proBNP (mean increase from  $33.9 \pm 23.6$  to  $152.1 \pm 109$  ( $p < 0.0001$ )). This was associated with echo evidence of diastolic dysfunction including a decrease in the transmitral E/A ratio ( $1.7 \pm 0.64$  to  $1.1 \pm 0.29$  ( $p = 0.001$ )) and early mitral annular velocities. Echo evidence of decreased systolic function was also present (table). A rise in NT-proBNP was independently correlated with a decrease in the early septal annular velocity ( $p = 0.002$ ). **Conclusions:** Marathon running is associated with a rise in a biochemical marker of ventricular dysfunction. This appears to be most closely associated with a change in diastolic annular velocities.

Echo Parameters of Ventricular Function

Parameter	Pre	Post	p value
Peak septal strain	$-24 \pm 5.6$	$-20 \pm 3$	<b>0.05</b>
Peak lateral strain	$-20 \pm 5.0$	$-17 \pm 3$	<b>0.04</b>
RVapical strain rate	$-2.8 \pm .86$	$-2 \pm 1$	<b>0.01</b>
Ea Septum	$-9.8 \pm 0.99$	$-8.3 \pm 2.9$	0.07

11:30 a.m.

840-7

### The Presence Of Mitral L Wave In Patients With Hypertrophic Cardiomyopathy Indicates Advanced Diastolic Dysfunction

Jong-Won Ha, Namsik Chung, Jeong-Ah Ahn, Seong-Hoon Choi, Seok-Min Kang, Se-Joong Rim, Yangsoo Jang, Won-Heum Shim, Seung-Yun Cho, Yonsei University College of Medicine, Seoul, South Korea

**Background:** The prominent mid-diastolic filling wave, which has been described as an L wave, is not infrequently encountered in patients with hypertrophic cardiomyopathy (HCM). However, the significance of L wave has not been explored previously in patients with HCM. The purpose of this study was to explore possible mechanisms and clinical implications of L wave in patients with HCM using Doppler tissue imaging (DTI) and proBNP.

**Methods and Results:** Fifty-five patients with HCM (41 male, 14 female; mean age,  $57 \pm 10$  years) were studied. Mitral L wave was defined when mitral flow is triphasic, including mid-diastolic flow velocity of at least 0.2 m/s, and sinus rhythm. Peak velocity of E, L, and A, and deceleration time (DT) of the E wave velocity were measured. Diastolic mitral annular velocities were measured at the septal corner of the mitral annulus by DTI from the apical 4-chamber view. ProBNP was measured at the time of echocardiogram using Elecys proBNP, a quantitative electrochemiluminescence immunoassay. Patients were classified into 2 groups: group 1 (n=16) included those had mitral L wave and group 2 (n=39) included those without mitral L wave. The heart rate was significantly lower in patients with group 1 ( $54 \pm 6$  vs  $62 \pm 10$ ,  $p = 0.013$ ). Group 1 patients had significantly higher E/A ( $1.6 \pm 0.1$  vs  $1.2 \pm 0.6$ ,  $p = .03$ ), and left atrial volume index ( $44 \pm 13$  vs  $32 \pm 10$  ml/m<sup>2</sup>,  $p = .003$ ). DT was significantly shorter in patients with group 1 ( $178 \pm 23$  vs  $214 \pm 43$  ms,  $p = 0.002$ ). However, E/E' ( $14 \pm 5$  vs  $14 \pm 8$ ,  $p = .86$ ) and E' ( $4.7 \pm 1.7$  vs  $4.8 \pm 1.4$  cm/s,  $p = .86$ ) were not significantly differ between the groups. ProBNP was significantly higher in group 1 ( $1442 \pm 361$  vs  $593 \pm 95$  pg/ml,  $p = .02$ ).

**Conclusion:** The presence of L wave in patients with HCM is associated with higher E/A, shorter DT, elevated proBNP and enlarged left atrium indicating advanced diastolic dysfunction with elevated filling pressures. This unique mitral inflow velocity pattern should be helpful in identifying the patients with advanced diastolic dysfunction and increased LV filling pressures in patients with HCM.

11:45 a.m.

840-8

### Importance of Routine Correction of Aortic Valve Area by Echo to Account for Pressure Recovery

Khalid Almuti, Garett Gordon, Daniel M. Spevack, Montefiore Medical Center, Bronx, NY

**Background:** ACC/AHA guidelines define severe aortic stenosis (AS) as an aortic valve area (AVA) of  $\leq 1.0$  cm<sup>2</sup>. Routine application of this value to AVA calculated by echo ( $AVA_{Echo}$ ) overestimates the prevalence of severe AS. Use of a cutoff for  $AVA_{Echo}$  of under 0.75 cm<sup>2</sup> is therefore commonly applied. Overestimation of AS severity by echo is largely attributed to the phenomenon of pressure recovery. After the forward jet loses velocity in the aortic root, the pressure increases or "recovers" distally, lowering the effective trans-valvular gradient. Catheters used in clinical practice measure pressure in the aortic root, downstream from the aortic valve after the pressure has recovered. Pressure recovery is less pronounced when the aortic root is dilated due to energy lost to turbulence. Measurement of  $AVA_{Echo}$  does not account for the aortic root size and the degree of pressure recovery and therefore may overestimate the severity of AS compared with catheter-derived values in patients with normal or small aortic roots.

**Methods:** Reports were reviewed of 217 consecutive patients with AS and without significant regurgitation, who underwent catheterization and echo for evaluation of AVA.  $AVA_{Echo}$  was modified using,  $(ARA * AVA_{Echo}) / (ARA - AVA_{Echo})$ , where ARA is aortic root cross-sectional area. This equation has been shown to predict the AVA on catheterization ( $AVA_{pred}$ ).

**Results:** Applying ACC/AHA guidelines to  $AVA_{Echo}$ , 181 patients had severe AS, 28 had moderate AS ( $AVA > 1$  and  $\leq 1.5$ ) and 8 had mild AS. Using AVA calculated by catheterization, 143 patients had severe AS, 57 had moderate AS and 17 had mild AS. Calculation of  $AVA_{pred}$  yielded 146 patients with severe AS, 54 with moderate AS and 17 with mild AS. Only 86 patients had  $AVA_{Echo}$  under 0.75 cm<sup>2</sup>.

**Conclusion:** Classification of AS severity using echo was similar to catheterization if corrected for the effect of pressure recovery. Classification of severe AS by echo underestimated the prevalence of severe AS when a threshold of under 0.75 cm<sup>2</sup> was used. Routine correction of AVA by echo to account for pressure recovery improves accuracy of classification and allows for a more standardized definition of AS severity.

## POSTER SESSION

### 1165 Clinical Applications of Transesophageal and Intracardiac Echocardiography

Tuesday, March 08, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 2:30 p.m.-3:30 p.m.

1165-87

#### Determination of Primary Entry Tear for Acute Aortic Dissection: Diagnostic Accuracy--Comparison of Transesophageal Echocardiogram and Surgical Findings

Alan X. Zhu, Richard Chang, Nan Wang, Anees Razzouk, Ramesh Bansal, Loma Linda University Medical Center, Loma Linda, CA

**Background:** The determination of primary entry tear (PET) for acute aortic dissection (AD) is important for operative strategy. There is limited information on the use of Transesophageal Echocardiogram (TEE) to identify the PET. The aim of this study was to evaluate the accuracy of TEE in identification of PET in a large series of patients going for surgery.

**Methods:** A series of 130 consecutive patients from 1988 to 2004 in one medical center were reviewed. The AD was confirmed at surgery for all patients. All of these patients also had pre-operative TEE. The TEE diagnosis for PET was compared with surgical report. If there was a discrepancy or entry tear information was unavailable on TEE report, the echocardiographic tapes were reviewed by an experienced echocardiographer without knowledge of surgical findings to identify the site and the possible reasons of discrepancy.

**Results:** There were total 130 patients, 90 males (69.2%) and 40 females (30.8%), mean age  $58.8 \pm 14.2$  (years). By DeBakey classification at the surgery, there were 91 patients (70%) with type I. Among them, there were 18 patients with noncommunicating dissection, 52 patients with PET in ascending aorta, 19 in arch and 2 in descending aorta. There were 21 patients (16.2%) with type II. Among type II, 3 patients had noncommunicating dissection, 15 patients having PET in ascending aorta and 3 in arch. For type III, there were 18 patients (13.8%). Of those, 3 patients had noncommunicating dissection, 2 patients with PET in distal arch and 13 patients in descending aorta. For communicating dissection, the accuracy of TEE in detection of PET was 87% (92/106). In noncommunicating, the accuracy of diagnosis was 100% (24/24). The entry tear was either missed or misdiagnosed in 14/106 patients (13.2%). Among the 14 misdiagnoses, 7 of them were due to significantly thrombosed false lumen, 3 of them being undetectable and 4 patients being due to miscellaneous misclassifications.

**Conclusions:** TEE had 87% accuracy in the detection of PET and 100% for intramural hematoma in the diagnosis of acute aortic dissection. The primary reason for misdiagnosis of primary entry tear was the significantly thrombosed false lumen with limited entry tear.

1165-88

#### Percutaneous Closure of Patent Foramen Ovale in Divers: Incidence of Decompression Illness and Ischemic Brain Lesions at 1-Year Follow-Up

Rainer Zbinden, Michael Billinger, Luca Remonda, Markus Scherzmann, Rolf Vogel, Stephan Windecker, Bernhard Meier, Christian Seiler, University Hospital Bern, Bern, Switzerland

**Background:** Patent foramen ovale (PFO) is related to an increased risk of decompression illness (DCI), and is associated with the presence of ischemic brain lesions in SCUBA-divers. It is unknown whether closure of PFO reduces the incidence of DCI and/or of ischemic brain lesions.

**Methods:** 104 divers were included in the study (mean age  $39 \pm 7$  years; 84 men), 65 with a PFO on transesophageal contrast echocardiography, 39 controls. PFO was occluded percutaneously using an Amplatzer-PFO-Occluder® in 26 divers (PFO-occlusion group). All divers completed a questionnaire to assess minor DCI-score (e.g. headache, paresthesia, joint-pain etc), and major DCI (treatment in decompression chamber) at inclusion and at follow-up. They underwent brain magnetic resonance imaging to count ischemic lesions at inclusion and follow-up.

**Results:** Mean follow-up time was  $374 \pm 35$  days, there were 6326 dives in total. There were no significant differences in baseline characteristics (age, gender, mean number of dives, mean diving depth, number of dives beyond 40 meters) between the three groups. There were no procedure related complications.

Minor DCI-score at follow-up differed significantly between the PFO-occlusion group and the PFO group ( PFO-occlusion group:  $1.1 \pm 1.2$  minor DCI, PFO group:  $2.4 \pm 2.0$  minor DCI;  $p=0.006$ ). The difference between the control-group and the PFO group, and between the control-group and the PFO-occlusion group was not significant.

3 major DCI were reported: 2 in the PFO group, 1 in the control group and none in the PFO-occlusion group ( $p=0.40$ ).

Mean number of ischemic brain lesions at inclusion was  $1.8 \pm 5.0$  lesions per person in the PFO group,  $0.9 \pm 2.2$  lesions in the control group,  $0.4 \pm 0.7$  lesions in the PFO-occlusion group, ( $p=NS$  (ANOVA overall)). Only one diver in the PFO-occlusion group had three new ischemic brain lesions at follow-up ( $p=NS$ )

**Conclusion:** PFO occlusion reduces minor DCI in SCUBA divers. Major DCI requiring treatment in a decompression chamber tend to be reduced with PFO occlusion.

At 1-year follow-up, there is no difference in the incidence of new ischemic brain lesions.

**1165-89 Value of Transesophageal Echocardiographic Findings as Risk Stratification for Embolic Complication During Long-Term Follow-Up of Five Years**

Karlheinz Seidl, Klaus Dönges, Elke Fromm, Thorsten Becker, Thomas Kleemann, Ömer Yildiz, Jochen Senges, Heart Center Ludwigshafen, Ludwigshafen, Germany

Aim of the study was to evaluate the long-term outcome in patients (pts) with atrial fibrillation (AF) according to the findings during transesophageal echocardiography (TEE) performed before cardioversion (CV).

**Methods:** TEE was performed in 787 pts with AF before CV at index admission. All pts were followed-up (FU) either on an outpatient basis or by telephone survey for a median of 65 months (50-84 months). Pts were classified in 5 groups according to the following TEE-findings in the left atrium or aorta: TEE normal, mild spontaneous echo contrast (SE), moderate/severe SE, LA-thrombus, only plaques in the aorta. Furthermore the quality of oral anticoagulation (OAC) was evaluated at the end of FU using the last 5 INR values. Effective OAC was defined if the INR value was in the range of 2-3.

**Conclusion:** 1. SE at index admission is a risk indicator for mortality and thromboembolic complication (TEC) during FU of 5 years. 2. Mortality and stroke rate was highest in pts with AF in whom LA-thrombi were detected. The risk for TEC during FU increased with the severity of SE. Pts with plaques in the aorta had a similar risk for TEC than pts with moderate/severe SE.

TEE findings as risk stratification for embolic complications

	n (pts)	OAC during FU (%)	death	stroke	severe bleeding
TEE normal	319 pts	61%	13.4%	2%	0.8%
mild SE	162 pts	71%	17.3%	7%	0.3%
severe/moderate SE	72 pts	85%	27.5%	9%	2%
LA-thrombi	97 pts	90%	30%	15.2%	0.7%
Plaque in aorta	137 pts	72%	19.5%	9.7%	0.8%

**1165-90 Initial Experience With A Left Atrial Appendage Filter Device For Stroke Prevention In Atrial Fibrillation**

Arashk Motiei, David R. Holmes, Douglas L. Packer, Barugur S. Ravi, Pamela Sinning, Farook Mookadam, Bijoy Khandheria, Krishnaswamy Chandrasekaran, Mayo Clinic, Rochester, MN

**Background:** Mechanical device occlusion of the left atrial appendage (LAA) may be an alternate to anticoagulant therapy for patients with atrial fibrillation.

**Objectives:** To study the safety and intermediate term efficacy of a novel LAA filter device (Watchman Filter Device)

**Methods:** Patients with atrial fibrillation at risk for stroke and on anticoagulation were enrolled. Transesophageal echocardiography was used to measure the LAA dimensions for device size selection. The device was implanted into the LAA by percutaneous means. Coumadin was discontinued after 45 days. Follow up TEE was performed at 45 days and 6 months.

**Results:** Eight of nine enrolled patients (age range 62-79 years) underwent LAA device occlusion. One patient with a large LAA (>30mm) diameter was excluded. The maximum LAA ostial width by TEE ranged from 21mm to 30.1mm. The implanted devices ranged from 21 to 30mm in size. In 5 patients, the device had to be re-sized and re-deployed during the procedure. This was due to complex anatomical factors including the asymmetry of the LAA ostium and relationships of pectinate muscles, accessory LAA lobes and their confluence with the ostium, and the configuration of the left superior pulmonary vein (LSPV) sleeve adjoining the LAA. In 3 patients where LAA geometry prevented proper device placement, the space between LUPV sleeve and the LAA ostium was used to deploy the device. One patient required the utilization of the accessory lobe for device deployment. The final device was deployed successfully in all 8 patients. There were no peri-procedural complications. All patients were off coumadin (2 weeks to 9 months) with no embolic events. Follow up TEE showed trivial peri-device flow in 4 of 7 patients at 45 days, and in 3 of 5 patients at 6 months. No device migration or intracardiac thrombi were observed.

**Conclusion:** This pilot study demonstrates that the LAA filter device can be safely placed. On intermediate-term follow up, the device is effective in preventing cardiogenic embolism in atrial fibrillation. TEE plays a valuable role in assessing the anatomy of the LAA and guiding the device placement.

1165-91

**Assesment of Interatrial Septum by Intracardiac Echocardiography and Transcranial Doppler Following Pulmonary Vein Antrum Isolation With Double Transseptal Puncture Technique**

Fethi Kilicaslan, Hirotsuke Yamaji, Nassir F Marrouche, Atul Verma, Jennifer E Cummings, Oussama Wazni, Huseyin Bozbas, Dhanumjaya Lakkireddy, William M Belden, Samy C Elayi, Luis C Saenz, Seil Oh, J David Burkhardt, Walid Saliba, Robert A Schweikert, Andrea Natale, The Cleveland Clinic Foundation, Cleveland, OH

**BACKGROUND:** For left atrial (LA) ablations, transseptal puncture (TP) is the standard access to LA. However, atrial septal defect (ASD) and right-to-left shunting (RLS) related to TP have been reported and may be a cause of paradoxical embolism. The incidence of residual ASD and RLS after pulmonary vein antrum isolation (PVAI) is unknown.

**OBJECTIVE:** We sought to assess interatrial septum continuity and to determine the presence of residual shunting immediately following PVAI. **METHODS:** Thirty patients undergoing PVAI for treatment of atrial fibrillation were studied. Patients had two TPs performed routinely using two 8-French Mullins transseptal sheaths. All patients had a baseline intracardiac echo (ICE) examination with pulse, continuous and color Doppler. Transcranial Doppler (TCD) examination with agitated saline injection during Valsalva maneuver was also done prior to TP. Out of 30 patients, baseline PFO was detected in 8 (27%) and they were excluded. The remaining 22 patients (mean age  $59 \pm 8$ , 4 female) were included. ICE was repeated and a second agitated saline study with Valsalva was done immediately following PVAI after the transseptal sheaths were withdrawn from the LA into the right atrium. Air microbubbles in the LA were counted by ICE and cerebral microembolic signals were monitored by TCD.

**RESULTS:** Mean EF and LA diameter were  $52 \pm 5\%$  and  $4.4 \pm 0.6$  cm respectively. Mean procedure time was  $182 \pm 48$  minutes. After the procedure, a small residual PFO was detected in 2 (9%) patients. ICE demonstrated microbubbles in the LA and TCD detected microembolic signals during agitated saline study in these two patients. Also small ASD was detected in 4 (18%) patients. Notably, in 5 of these 6 cases, transseptal access was lost during manipulation of the ablation catheter during PVAI, and transseptal access had to be reobtained.

**CONCLUSIONS:** Double transseptal puncture does not result in significant left-to-right or right-to-left shunting in most patients. Rare cases of residue small ASD and RLS may occur especially when repeated transseptal puncture is required.

1165-92

**Use of Intracardiac Echocardiography for Closure of Atrial Communications in Patients Less Than 15 Kilograms**

Angira Patel, Qi-Ling Cao, Peter R. Koenig, Ziyad M. Hijazi, University of Chicago Children's Hospital, Chicago, IL

**BACKGROUND:** Intracardiac echocardiography (ICE) is increasingly replacing transesophageal echocardiography (TEE) as the primary imaging technique to guide device closure of atrial septal defects (ASD). Use of TEE requires general anesthesia due to length of the procedure. Investigators have reported the efficacy of ICE in adults and children. However, most studies have shown its use in individuals with weight above 15 kg. This study examines the use of ICE guided secundum ASD closure in children less than 15kg.

**METHODS:** 17 patients with a median age of 2.8 yrs (range 1.8 to 4.8) and median weight of 13.2kg (range 8.0 to 14.4) underwent transcatheter occlusion (Amplatzer occluder) of a secundum ASD using ICE guidance. ICE was performed using an AcuNav® catheter. The ICE catheter (10.5 Fr) was introduced into an 11 Fr sheath in a contralateral femoral vein. Diagnostic as well as periprocedure imaging was obtained.

**RESULTS:** 15 patients had single, and 2 had multiple defects. Median defect size as measured by ICE was 15mm (range 2.5 to 25). The median balloon stretched diameter (obtained in 7 patients) was 17mm (range 10 to 21); the median size of the defect for these 7 patients was 15mm (range of 8 to 20). Both techniques for measuring the defect correlated well with  $r=0.94$ . The ASD occluder size ranged from 7 to 26mm with a median of 18mm. 14 patients experienced successful device placement with no residual shunt. ASD occlusion was not attempted in 2 patients due to deficient rims; 1 attempt failed due to left atrial disk prolapse through the ASD. 3 patients experienced complications during the catheter procedure including SVT, sinus bradycardia, and complete heart block (resolving with device removal); all had subsequent successful device placement. No complications were attributed to the use of ICE and specifically, no vascular injury was noted.

**CONCLUSIONS:** Comparable to results with larger patients, ICE provides adequate imaging (preprocedure diagnosis and periprocedure guidance) during device occlusion of secundum ASD's with no significant complications. Thus, ICE can successfully be used in the closure of ASD in smaller patients (less than 15 kg) and eliminate the need for general endotracheal anesthesia.

1165-93

**Intracardiac Echocardiography Guidance During Percutaneous Transluminal Septal Myocardial Ablation in Patients With Obstructive Hypertrophic Cardiomyopathy**

Chiara Pedone, Maniyal Vijayakumar, Elena Biagini, Patrick W. Serruys, Folkert J. ten Cate, Bellaria Hospital, Bologna, Italy, Thoraxcenter Erasmus MC, Rotterdam, The Netherlands

**Background:** Percutaneous transluminal septal myocardial ablation (PTSMA) recently emerged as an alternative to myectomy for hypertrophic obstructive cardiomyopathy (HOCM) patients with drug-refractory symptoms. The potential role of intracardiac echocardiography (ICE) in guiding PTSMA has never been tested.

**Methods:** Nine consecutive HOCM patients (age range 47 to 75 yrs, 4 men) underwent PTSMA under intracardiac echocardiography (ICE) guidance (AcuNav 6-7 MHz phased-array transducer interfaced with Cypress, Acuson). The catheter tip was placed toward

right side of the interventricular septum providing a long axis view of the left ventricle. Images were obtained continuously during the procedures and acquired at baseline, after contrast (Levovist, Schering, Berlin) and ethanol injection into the target septal branch. Peri-procedural clinical data were collected.

**Results:** PTSMA were effective to reduce left ventricle outflow tract gradient from  $75 \pm 30$  to  $5 \pm 9$  mmHg ( $p < 0.001$ ). None of the patients had haemodynamic compromise or significant arrhythmias during the procedure; one patient developed complete heart block requiring permanent dual chamber pacing. There were no ICE related complications. After contrast injection risk area could be clearly visualized in all the patients and it guided the choice of the target septal branch. After the ethanol delivery an hyperechoic, sharply demarcated triangular area appeared (ablated area) within septum as result of local interaction of contrast microbubble with injected ethanol. Mean ablated planimetric area was  $1.9 \pm 0.7$  cm<sup>2</sup> (0.6-2.6).

**Conclusions:** In this initial experience ICE monitoring during PTSMA was safe and provided high quality and continuous imaging of the treated segment of the septum during the whole procedure. ICE may be considered as complete guiding tool during PTSMA.

#### 1165-94 Development of A New Small Animal Model of Chronic Mitral Regurgitation Under Transesophageal Echocardiographic Guidance

Zhaohui Gao, Jianhua Li, William Davidson, Jr., Lawrence Sinoway, Min Pu, Penn State University, Hershey Medical Center, Hershey, PA

**Background:** Large animal models (dog or sheep) are often used for the investigation of the pathophysiology of chronic mitral regurgitation (MR), but are very costly. We hypothesized that a cost-effective animal model of chronic MR could be developed in small animals.

**Methods:** Twenty-two male rats underwent open chest surgery to create chronic MR. Transesophageal echocardiography (TEE) was performed using an intracardiac echocardiography catheter. Under TEE guidance, a fine needle was inserted into the apex of the left ventricle (LV) to damage the mitral leaflets. Twelve rats had sham operations without MR produced. Color Doppler TEE was performed to assess the severity of MR. Transthoracic echocardiography was performed to assess LV remodeling and function. LV end-diastolic diameter (LVEDD), end-systolic diameter (LVESD), fractional shortening (FS) were measured 1 week prior to, and 1, 6, and 12 weeks post procedure. Rats were followed up for mean  $243 \pm 22$  days for evaluation of all-cause mortality. Costs were calculated using a fee-scale from our animal facility.

**Results:** Mean MR jet areas were  $17 \pm 4$  mm<sup>2</sup> in the MR group and there was no MR in the sham group. There were no significant differences in LVEDD ( $7.5 \pm 0.5$  vs.  $7.3 \pm 0.4$  mm,  $p > 0.05$ ), LVESD ( $4.0 \pm 0.4$  vs.  $4.1 \pm 0.9$  mm,  $p > 0.05$ ), FS ( $47 \pm 5\%$  vs.  $44 \pm 10\%$ ,  $p > 0.05$ ) between the sham and MR groups prior to introduction of MR. At the 12th week post the procedure LV was significantly larger in the MR group (LVEDD:  $11.3 \pm 1.4$  mm, LVESD:  $7.0 \pm 1.2$  mm) than in the sham group (LVEDD:  $8.9 \pm 0.8$  mm,  $p < 0.01$ , LVESD:  $4.8 \pm 0.8$  mm,  $p < 0.01$ ). FS were significantly lower in the MR group ( $39 \pm 6\%$ ) than that in the sham group ( $47 \pm 7\%$ ,  $p < 0.01$ ). Survival rate was significantly lower in the MR group than in the sham group ( $50\%$  vs.  $100\%$ ,  $p < 0.01$ ). The costs of the rat model of chronic MR were 40 times lower than that of large animal models.

**Conclusion:** Development of rat model of chronic MR under TEE guidance is feasible and cost-effective. This new model has demonstrated a pathophysiology similar to large animal models. It may be used for 1) the study of molecular and cellular mechanisms of LV remodeling and dysfunction in chronic MR and 2) the assessment of potential medical therapies for chronic MR.

#### POSTER SESSION

#### 1166 Clinical Evaluation Using Contrast Echocardiography

Tuesday, March 08, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 2:30 p.m.-3:30 p.m.

#### 1166-79 Myocardial Tissue Protection With Distal Coronary Protection and Adenosine Triphosphate Disodium Infusion Can Further Reduce No-Reflow in Acute Myocardial Infarction

Tadamichi Sakuma, Takenori Okada, Ken Ishibashi, Kentaro Miura, Toshiharu Oka, Mamoru Toyofuku, Hidekazu Hirao, Yuuji Muraoka, Hironori Ueda, Yoshiko Maseoka, Yasuhiko Hayashi, Shinji Mito, Tsuchiya General Hospital, Hiroshima, Japan, Hiroshima University, Hiroshima, Japan

**Background:** It remains unknown whether thrombectomy with distal coronary protection and appropriate pharmacological intervention can further reduce no-reflow in patients with acute myocardial infarction (AMI).

**Methods:** One hundred twenty-five consecutive patients with first anteroapical AMI were enrolled. In whom, culprit lesion was confirmed on proximal LAD with TIMI 0 or 1, and TIMI grade 3 recanalization(R) with less than 20% diameter stenosis was achieved by primary percutaneous coronary intervention (PCI) within 8 hours after symptom onset. They underwent PCI with GuardWire Plus System® (GPS; temporary occlusion & aspiration system) (n=23) or PCI with adenosine triphosphate disodium (ATP) (n=26) or PCI with both GPS and ATP (n=23) or PCI without any protections (n=53). ATP at a dose of 150 µg/kg/min was intravenously administered from 10 min prior to R to 50 min after R. We measured risk areas (asynergic region in apical long axis view) before R, and reperfusion

injury by documentation of ST segment re-elevation shortly after R, and left ventricular ejection fraction (LVEF), regional wall motion within the LAD region (RWM; SD/chord) and left ventricular end-diastolic volume (ml) (LVEDV) on both day 0 and 6months after R. No-reflow size (% risk area) was determined using ECG triggered 1.5 harmonic-myocardial contrast echocardiography 2weeks after R. Data was shown as mean(1SD), \*shows  $p < 0.05$  vs. control

**Results:** On day 0, risk area size, RWM, LVEF, LVEDV, collateral circulation, and time from symptom onset to R were similar in 4 groups. However, frequency of reperfusion injury (35%\*, 25%\*, 20%\*, 56%; GPS, ATP, GPS with ATP, Control in this order), documentation of malignant arrhythmia (Vf, VT, etc.) (23%, 18%\*, 13%\*, 36%), no-reflow size (27(24)%\*, 15(18)%\*, 12(16)%\*, 33(27)%), LVEF at 6months (57 (14), 64 (16)\*, 67 (15) \*, 53 (15)), RWM at 6months (-1.97 (1.00), -1.66 (0.72)\*, -1.54 (0.71) \*, -2.35 (0.75), and LVEDV at 6months (90 (29)\*, 87 (28)\*, 84 (28)\*, 115 (59)) were significantly different.

**Conclusions:** Distal coronary protection for thrombus as well as plaque burden with ATP infusion during reperfusion can significantly reduce no-reflow and improve left ventricular function in AMI patients.

#### 1166-80 Hypertriglyceridemia by Itself Deteriorates the Coronary Circulation: Real-Time Myocardial Contrast Echocardiographic Study

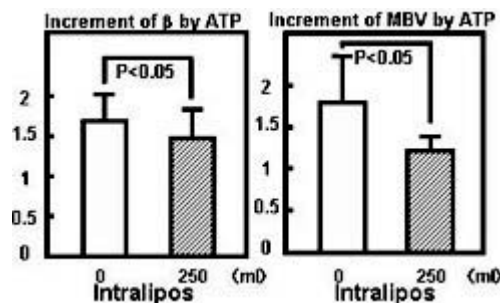
Kasumi Masuda, Fuminobu Ishikura, Kohel Okuda, Kentaro Otani, Toshihiko Asanuma, Shintaro Beppu, Osaka University Graduate School of Medicine, Suita, Japan

**Aim:** It is reported that hyperlipidemia may deteriorate the coronary circulation by itself, although its precise mechanism have not been elucidated. The aim is to examine the effect of acute hypertriglyceridemia on coronary circulation using real-time myocardial contrast echocardiography (MCE).

**Methods:** Hypertriglyceridemia was induced by rapid infusion of fat emulsion (Intralipos®) in 9 normal dogs. Coronary flow volume was measured by a flowmeter set on the left anterior descending artery (LAD), and coronary flow reserve (CFR) was determined by adenosine triphosphate (ATP) administration. MCE was examined using SIEMENS Sequoia-512 during infusion of Definity®. The replenishment curve was obtained to measure "β" in the equation of  $y = A(1 - e^{-\beta t})$ . To calculate the myocardial blood volume (MBV), square of acoustic unit at both septum ( $AU_{\text{septum}}^2$ ) and its adjacent LV cavity ( $AU_{\text{LV}}^2$ ) were measured and the formula of  $100 \times AU_{\text{septum}}^2 / AU_{\text{LV}}^2$  (ml/100g) was applied.

**Results:** After lipid administration, each of the blood viscosity, LAD flow and MBV increased, but CFR and "β" decreased even at rest. Although both MBV and "β" increased after ATP, their increasing rates decreased from  $1.80 \pm 0.57$  to  $1.22 \pm 0.17$ , and  $1.72 \pm 0.31$  to  $1.57 \pm 0.42$ , respectively, by lipid administration.

**Conclusions:** These data suggested that dilatation of myocardial microvessels compensates high shear stress of viscous blood by hypertriglyceridemia. This should be the mechanism of deterioration of the coronary circulation by hypertriglyceridemia.



#### 1166-81 Myocardial Microcirculation and Left Ventricular Diastolic Dysfunction in Obstructive Sleep Apnea Syndrome

Akira Yamada, Akiko Noda, Hideo Izawa, Tomoko Kato, Toyoaki Murohara, Mitsuhiro Yokota, Nagoya University Graduate School of Medicine, Nagoya, Japan

**Background:** Patients with obstructive sleep apnea syndrome (OSAS) often have hypertension with left ventricular (LV) hypertrophy (LVH). We investigated the influence of OSAS on myocardial microcirculation applying myocardial contrast echocardiography (MCE).

**Methods:** MCE was performed for 27 patients with OSAS (Group OSAS;  $49.3 \pm 7.4$  years), 41 hypertensive patients without OSAS (Group HT;  $51.3 \pm 8.1$  years) and 26 healthy controls (Group C;  $47.8 \pm 6.2$  years). Images were obtained from the apical two- and four-chamber views at pulsing intervals of one to four cardiac cycles with bolus infusion of Levovist. The color pixel intensity was determined at 8 different regions of interest in the LV myocardium (inferior base and apex, anterior base and apex, septal base and apex, lateral base and apex) and within the chamber adjacent to them. Standard polysomnography was performed in OSAS patients to determine the number of apnea and hypopnea episodes or oxygen desaturation per hour (apnea-hypopnea index (AHI), oxygen desaturation index (ODI)).

The mean contrast intensity difference (ID) between myocardium and chamber in all regions was significantly greater in Group OSAS than in Group C ( $26.7 \pm 3.6$  Versus  $21.0 \pm 2.1$  dB,  $p < 0.05$ ) and within those with AHI  $< 30$ /hr.

**Conclusions:** The repeated episodes of nocturnal oxygen desaturation, sleep fragmentation, and the consequent activation of the sympathoadrenal system in OSAS may involve in myocardial microcirculation impairment and LV diastolic dysfunction.



**1166-82** **Detection Of Left Anterior Descending Coronary Artery Obstruction By Myocardial Flow Reserve As Determined By Real-time Contrast Echocardiography. A Head To Head Comparison With Transthoracic Doppler.**

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**Background:** Real-time myocardial contrast echocardiography (RTMCE) is a new technique that allows for detection of coronary artery disease (CAD) by evaluating the regional myocardial blood flow. Although the decrease in myocardial blood flow reserve (MBFR) is indicative of CAD, a direct comparison with the coronary flow reserve (CFR) obtained by transthoracic Doppler echocardiography (DE) has not been fully demonstrated. In this study we sought to determine the value of MBFR and CFR for detecting left anterior descending artery (LAD) stenosis.

**Methods:** We studied 44 patients (18 men, 57±13 years) with RTMCE at rest and during 140mcg/kg/min of adenosine infusion. Plateau intensity (A) and myocardial replenishment velocity (B) were quantified with Q-Lab 2.0 (Philips), and MBFR calculated as the ratio of AxB during adenosine/baseline. CFR was calculated as the ratio of peak diastolic velocity obtained by DE during adenosine/baseline. LAD stenosis (>50%) was determined by quantitative angiography performed within 1 week of RTMCE.

**Results:** MBFR and CFR were lower in the 28 pts with LAD stenosis than in the 16 pts with normal LAD (Table). A cut-off value of 1.75 and 1.90 were obtained for differentiating normal and abnormal MBFR and CFR, respectively. The sensitivity, specificity and accuracy for detecting LAD stenosis were 85%, 80% and 81% for MBFR and 85%, 100% and 81% for CFR (p=NS).

**Conclusion:** Quantitative RTMCE and transthoracic DE had similar ability to differentiate patients with and without LAD stenosis.

\*p<0.05 compared to normal LAD

	Normal LAD	Normal LAD	Normal LAD	LAD Stenosis	LAD Stenosis	LAD Stenosis
Variables	Baseline	Adenosine	Reserve (Adenosine/Baseline)	Baseline	Adenosine	Reserve (Adenosine/Baseline)
A value	5.62 ± 1.77	6.11 ± 1.56	1.17 ± 0.44	5.60 ± 1.91	5.88 ± 1.74	1.12 ± 0.38
B value	0.50 ± 0.15	1.04 ± 0.54	2.08 ± 0.82	0.49 ± 0.18	0.57 ± 0.23*	1.23 ± 0.46*
Myocardial blood flow (RTMCE)	2.74 ± 1.38	6.37 ± 2.87	2.43 ± 0.80	2.86 ± 1.67	3.18 ± 1.59*	1.24 ± 0.48*
Peak Diastolic Velocity (DE)	24.8 ± 8.5	68.8 ± 23.4	2.86 ± 0.71	30.1 ± 10.6	48.6 ± 23.9*	1.57 ± 0.38*

**1166-83** **Clinical Usefulness of Myocardial Contrast Echocardiography and Tirofiban in Identification and Treatment of High Risk Chest Pain Patients**

Duk-Hyun Kang, Duk-Woo Park, Soo-Jin Kang, Kwan-Ho Ko, Kyoung-Ha Park, Jong-Min Song, Kee-Jun Choi, Myeong-Ki Hong, Jae-Kwan Song, Seong-Wook Park, Seung-Jung Park, Asan Medical Center, Seoul, South Korea

**Background:** Myocardial contrast echocardiography (MCE) was expected to be clinically useful in diagnosing high risk chest pain patients. We sought to evaluate clinical efficacy of tirofiban in acute coronary syndrome diagnosed by MCE.

**Methods:** Using intermittent power doppler harmonic imaging and continuous infusion of PESDA, MCE was performed to assess myocardial perfusion in patients presenting to emergency room with suspected ischemic chest pain at rest. Exclusion criteria were age > 75 yrs, pregnancy, presence of Q wave or ST segment elevation, poor echo window, and refusal of consent. Positive MCE was defined as presence of myocardial perfusion defects in at least 1 coronary artery territory. A total of 63 patients (age: 59 ± 10 yrs, 51 men) with positive MCE were randomly assigned to either tirofiban group (n=32) or control group (n=31). The primary end point was a composite of death and nonfatal myocardial infarction (MI) occurring after the index event.

**Results:** The initial troponin I level was elevated in 22(35%) patients, and ST depression was noted in 18(29%) patients. Coronary angiography was performed in all patients, and percutaneous coronary intervention (PCI) in 44(70%) patients, coronary artery bypass graft surgery (CABG) in 10(16%) patients. The final diagnosis at discharge was unstable angina in 21(33%) patients, non ST elevation MI in 41(65%) patients, and non-ischemic chest pain in 1(2%) patient. There were no significant differences between two groups in terms of baseline characteristics, and time to PCI (2.9 ± 1.2 days in tirofiban group vs 2.6 ± 1.6 days in control, p = NS). The tirofiban group had a slightly higher frequency of PCI (72% vs. 68%, p = NS) and lower frequency of CABG (13% vs. 19%, p = NS) than control. Adverse events occurred in 4 (13%) patients (2 deaths, 2 MI) of control, compared with no event in tirofiban group (p < 0.05). The event-free survival rates were 93 ± 5% at 1 yr and 82 ± 8% at 2 yrs in control and significantly worse than those in tirofiban group (p < 0.05).

**Conclusions:** MCE can identify high risk chest pain patients, and early use of tirofiban is associated with favorable outcomes in these patients with acute coronary syndrome diagnosed by MCE.

**1166-84** **Prognostic Value of Myocardial Contrast Echocardiography in Patients Presenting to Hospital with Acute Chest Pain and Negative Troponin**

Paramjit Jeetley, Leah Burden, Kim Greaves, Roxy Senior, Northwick Park Hospital, Harrow, United Kingdom

**Background:** Myocardial contrast echocardiography (MCE) is a new bedside technique that facilitates the diagnosis of coronary artery disease (CAD). We hypothesized that MCE can be used to risk stratify patients with coronary risk factors presenting to hospital with acute chest pain, non-diagnostic ECGs and negative 12 hour-troponin.

**Methods:** All subjects underwent standard clinical tests for risk stratification. Subsequently low power MCE was performed using SonoVue as a continuous infusion at rest and following vasodilator stress. Patients were recommended for coronary angiography by treating physicians on the basis of standard tests for risk stratification and blinded to MCE results.

**Results:** A total of 139 patients underwent MCE at a mean time of 17±27 days after admission. At coronary angiography, 26 (19%) patients were found to have significant CAD, 21(81%) of which were detected by MCE. At follow-up (7.3±4.1 months), patients with an abnormal MCE (n=49 pts) had higher cardiac event rates (death, non-fatal myocardial infarction and urgent revascularisation) compared to those with normal MCE (36% vs 7%; p<0.0001). Hard cardiac event rates (death and non-fatal myocardial infarction) were low (3% in the patients with normal MCE (n=90 pts).

**Conclusion:** MCE accurately classified patients presenting to the hospital with coronary risk factors but troponin negative chest pain into high and low risk groups. A normal MCE confers an excellent prognosis in such patients.

**1166-85** **Myocardial Contrast Echocardiography Accurately Estimate Transmurality and Size of Acute Myocardial Infarction.**

Maria L. Trindade, Altamiro F. Osorio, Ingrid Kowatsch, Marcia A. Caldas, Vitor Monsao, Carlos E. Rochitte, Jose L. Andrade, Wilson Mathias, Jr., Heart Institute (InCor), São Paulo, Brazil

**Background:** In acute myocardial infarction (AMI), accurate of it's extent is still a challenging issue involving availability of technology, scarcity of appropriate clinical quantitative validation and cost. Quantitative myocardial contrast echocardiography (QMCE) with parametric imaging (PI) and gray scale low mechanical index 2 dimensional echocardiography (2D echo) has been promising in determining the location and severity of AMI. We sought to evaluate the correlation of 2D echo and QMCE with magnetic resonance imaging (MRI) in determining location, transmural extent and size of AMI.

**Methods:** We prospectively evaluated 20 patients (12 men, 64.25 ± 13.3 years) admitted for AMI from June 2003 to July 2004. PI and 2D echo were used to measure the segmental location, infarct area (cm<sup>2</sup>), % infarct area, transmural extent (cm) and % transmural extent using a 17-segment model. Studies were performed with a Sonos 5500 and quantified with a QLab software (Philips medical systems), and were compared with MRI late enhanced imaging.

**Results:** There were 10 AMI in anterior, 5 in inferior and 5 in lateral wall, and there were 266 infarcted segments by MRI. The echocardiographic correlations with that of MRI are shown below.

**Conclusion:** These results suggests that QMCE, in especial PI, correlates well with MRI in detecting infarct location, size and transmural extent, therefore this technique has the potential to be the ideal, first hand tool for evaluating the extent of AMI.

The echocardiographic correlations with that of MRI

	MRI	2D ECHO	PI
Segmental Location	-	259/266(r=0.98)	263/266(r=0.99)
Infarct area (cm <sup>2</sup> )	3.42 ± 2.80	3.03 ± 2.77(r=0.97 p=0.0001)	3.36 ± 2.82(r=0.99 p=0.0001)
% Infarct area	16.76 ± 14.48	15.22 ± 14.84(r=0.97 p=0.0001)	16.46 ± 14.41(r=0.99 p=0.0001)
Transmural extent (cm)	0.64 ± 0.36	0.60 ± 0.37(r=0.79 p=0.0001)	0.68 ± 0.28 (r=0.84 p=0.0001)
% Transmural extent	75.10 ± 29.27	71.49 ± 38.12(r=0.74 p=0.0002)	78.29 ± 25.11(r=0.84 p=0.0001)

**1166-86** **Safety and Feasibility of Real Time Myocardial Perfusion Imaging With Intravenous Ultrasound Contrast During Dobutamine Stress Echocardiography**

Jeanne Mike Tsutsui, Feng Xie, Abdou Elhendy, Anna C. McGrain, Brian Cory, Robert Garvin, Thomas R. Porter, University of Nebraska Medical Center, Omaha, NE

**Background:** Although myocardial perfusion analysis (MPA) with intravenous (IV) ultrasound contrast (UC) and real-time myocardial contrast echocardiography (RTMCE) may improve the sensitivity of dobutamine stress echocardiography (DSE), two potential concerns exist. First, ultrasound-induced microbubble destruction has been reported to stimulate arrhythmias during DSE. Secondly, the feasibility of performing MPA with RTMCE has not been evaluated in a large series of patients.

**Methods:** Accordingly, we examined 1,487 pts (60±13 years) who underwent dobutamine stress RTMCE, as well as 1,012 control pts (63±13 years) who underwent DSE without UC. To reduce microbubble destruction, RTMCE was performed with low-mechanical index (<0.3) pulse sequence schemes following IV UC (Optison or Definity). Blood pressure, 12 lead electrocardiograms, and symptoms were assessed during each infusion stage. Feasibility was defined as the ability to perform MPA in at least 2 of 3 segments in each left ventricular wall (septal, lateral, inferior, anterior, posterior).

**Results:** The mean dose of IV Optison per study was 2.8±0.8 ml, while it was 1.0±0.3 ml for Definity. No myocardial infarction or death occurred in either group, and there was no difference in any type of arrhythmia (Table). MPA was feasible in 93% of the walls at baseline and 94% at peak stress.

**Conclusion:** Dobutamine stress RTMCE is a safe and feasible test for evaluating patients with known or suspected coronary artery disease.

Adverse effects	RTMCE (n = 1,487)	DSE (n = 1,012)
Premature ventricular complexes	348 (23.4%)	230 (22.7%)
Premature supraventricular complexes	71 (4.8%)	44 (4.3%)
Supraventricular tachycardia	21 (1.4%)	19 (1.9%)
Atrial fibrillation	27 (1.8%)	14 (1.4%)
Nonsustained ventricular tachycardia	20 (1.3%)	8 (0.8%)
Sustained ventricular tachycardia	5 (0.3%)	3 (0.2%)
Combined sustained arrhythmias	53 (3.6%)	36 (3.5%)
Hypotension	189 (12.7%)	127 (12.5%)
Hypertension	27 (1.8%)	15 (1.5%)

## POSTER SESSION

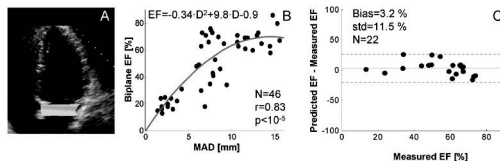
## 1167 Technical Advances in Tissue Velocity, Strain, and Torsion

Tuesday, March 08, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 2:30 p.m.-3:30 p.m.

### 1167-71 Automated Quantitative Measurement of Mitral Annular Longitudinal Displacement Using Tissue Texture Tracking Allows Ultrafast Assessment of LV Ejection Fraction

Jeanne M. DeCara, Eran Toledo, Ivan S. Salgo, Georgeanne Lammertin, Lynn Weinert, Victor Mor-Avi, Roberto M. Lang, University of Chicago, Chicago, IL

The calculation of LV ejection fraction (EF) based on manual tracing of endocardial borders is time-consuming and relies on adequate endocardial visualization. Mitral annular displacement (MAD) has been used as a surrogate marker of LV systolic function. We developed a technique for automated quantification of MAD and tested its accuracy for ultrafast assessment of LV systolic function. Methods. Apical 4-chamber views obtained in 68 patients were used for off-line automated tissue-texture tracking and frame-by-frame color-encoding of mitral annular motion throughout systole (Q-LAB, Philips). Color-encoded images (fig. A) were analyzed to quantify MAD using custom software. In 46 pts (study group), MAD values were correlated with biplane EF (method of discs) to obtain a regression formula, which was then applied prospectively to predict EF in the remaining 22 pts (test group). Results. Mitral annular tracking, color-encoding and quantification of MAD was achieved in all pts within <10 sec. MAD correlated highly with EF in the study group and was fitted with a bilinear regression formula (fig. B). When tested prospectively using this formula, MAD predicted EF with minimal inter-technique differences (fig. C;  $r=0.80$ ,  $p<0.00001$ ). Conclusions. Quantification of MAD from color-encoded images provides accurate information on LV systolic function. This automated, ultrafast technique can be used even in patients with poorly visualized endocardium, since the mitral annulus is usually well visualized.



### 1167-72 Radial and Longitudinal Myocardial Velocity Estimation From Gray-Scale Conventional Echocardiography. Validation Against Doppler Velocities.

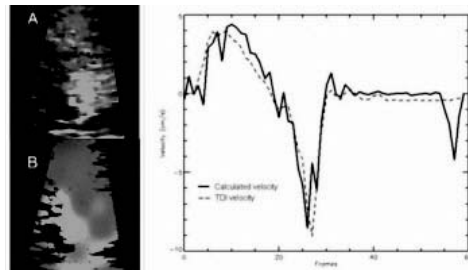
María Jesus Ledesma-Carbayo, Manuel Desco, Norberto Malpica, Patricia Mahía, Esther Pérez David, Andres Santos, Miguel Angel García Fernández, Hospital General Universitario Gregorio Marañón, Madrid, Spain

**Background:** Measurements of myocardial velocity (V) using Tissue Doppler Imaging (TDI) has the intrinsic limitation of the angular dependency. This work presents a new method to obtain radial and longitudinal myocardial velocities from 2D gray-scale echocardiographic sequences and its validation against Tissue Doppler Imaging (TDI) velocities.

**Methods:** TDI and gray scale sequences of the septum (apical view) were acquired simultaneously from normal volunteers with an Acuson Sequoia at a frame rate of 110 fps, and analyzing V with both methods. The 2D velocity vector, that enclose the radial and longitudinal components, was obtained by means of an automatic motion detection method based on non-rigid registration of consecutive frames. Linear regression analysis was applied to assess the relationship between the V calculated with the proposed method (Vr) and Doppler velocities (Vd).

**Results:** Linear regression results showed a good correlation between Vr and Vd (slope =  $0.846 \pm 0.003$ ,  $R^2 = 0.782$ ). Figure shows a standard TDI image (A), the equivalent image obtained with the proposed method (B), and the corresponding velocity time curves from a ROI.

**Conclusions:** Non-rigid registration techniques allow obtaining radial and longitudinal components of V from conventional gray-scale imaging, overcoming the limitations of Doppler techniques.



### 1167-73 Single Beat Determination of Regional Myocardial Strain Measurements in Patients with Atrial Fibrillation

Kaoru Funabiki, Katsuya Onishi, Masaki Tanabe, Takashi Yamanaka, Masaaki Ito, Naoki Isaka, Takeshi Nakano, Mie University School of Medicine, Tsu, Japan

**Background:** Evaluation of regional myocardial function is an important goal in clinical cardiology. The clinical assessment of regional myocardial function in patients with atrial fibrillation is unreliable and difficult because of beat-to-beat variation. Recent reports have shown that the ratio of preceding (RR1) to preceding RR intervals (RR2), RR1/RR2 can assess left ventricular systolic function. Accordingly, we tested the hypothesis that regional wall motion can be estimated from single beat based on RR1/RR2 in patients with atrial fibrillation.

**Methods and Results:** Peak systolic strain was measured by tissue Doppler image (Vivid 7, GE Medical Systems, USA) on apical 4 chamber view in 50 patients with atrial fibrillation (mean ejection fraction  $0.52 \pm 0.16$ , and mean heart rate  $76 \pm 16$  bpm). Each left ventricular wall was divided into base, middle and apex and all measurements were recorded during  $30 \pm 10$  cardiac cycles in each patient. Peak strain in each segments showed a positive correlation with the RR1 and RR2, and a significant positive correlation with the RR1/RR2 ratio. The correlation coefficients were significantly greater for the relationship between the peak strain and the RR1/RR2 ratio than for those between the parameter and the RR1 or RR2. Furthermore, the peak strain at RR1/RR2=1 was calculated from the equation of linear regression line and compared with measured average value over all cardiac cycles in each patient. The calculated value of each parameter at RR1=RR2 was quite similar to the average value ( $r=0.997$  at base,  $0.998$  at middle and  $0.996$  at apex).

**Conclusions:** Regional myocardial strain at RR1/RR2=1 in the linear regression line could be the representative of average value over all cardiac cycle in each patients with atrial fibrillation.

### 1167-74 Relationship of Left Ventricular Apical Torsion to Longitudinal Mechanics in Health and Disease

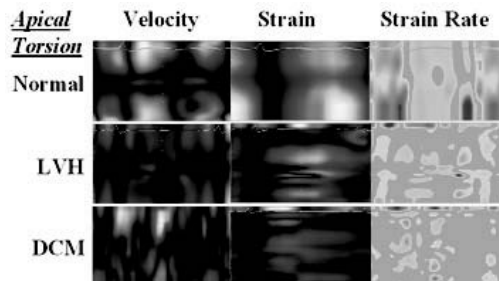
Huy Trong Nguyen, Peng Li, Hirsch Mehta, Mai T. Pham-Dunong, Cynthia D. Dell, Margaret L. Knoll, Gianni Pedrizzetti, Giovanni Tonti, Helene Houle, Chowdhury Ahsan, Jagat Narula, Mani A. Vannan, University of California Irvine, Irvine, CA

**Background:** LV torsion is a critical determinant of pump ejection. Longitudinal myocardial velocity (MV), strain (S) and strain rate (SR) by TDI is an index of LV function, but TDI is limited by angle-dependency to assess apical torsion. We studied the relationship between apical torsion and longitudinal mechanics in normal and abnormal LV using a novel B-mode, high frame rate (FR), angle-independent, automated myocardial tracking algorithm (*Diogenes*).

**Methods:** 30 individuals (10 normals, 10 DCM and 10 hypertensive LVH) were studied. High FR (~100 Hz), B-Mode SAX view of LV apex and apical 4C views obtained using 4V2 TTE probe linked to Acuson Sequoia™ (*Siemens*). The endocardial border was traced over one arbitrary frame and was then automatically tracked over time (*Diogenes*, Amid-Italy & Siemens, USA). MV, S and SR were measured in the basal-mid septum (septum) in the A4C view and the apical SAX view.

**Results:** Septal MV was comparable in normals and LVH ( $p=0.3$ ) but reduced in DCM ( $p=0.005$ ). Septal S and SR was reduced (Vs. normals) by  $45 \pm 0.4\%$  and  $64 \pm 0.2\%$  in LVH and by  $66 \pm 0.3\%$  and  $75 \pm 0.1\%$  in DCM, respectively. Apical twist was reduced in both LVH (8.9%,  $p=0.02$ ) and DCM (23.6%,  $p=0.0001$ ) compared to normals, see figure below.

**Conclusions:** Longitudinal myocardial mechanics is determined by apical torsion. Disruption of apical twist disrupts longitudinal S and SR although MV may be normal, as seen in LVH. *Diogenes* based on myocardial tracking affords a method to measure apical torsion.



**1167-75 Measurement of Apical Torsion in Mitochondrial Cardiomyopathy Using a Novel B-Mode, Automated Tracking Algorithm**

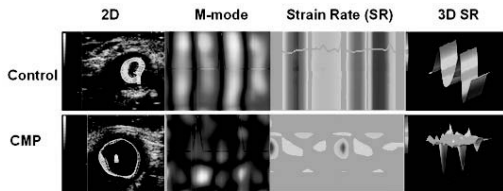
Peng Li, Giovanni Tonti, Johan Verjans, Gianni Pedrizzetti, Hirsch Mehta, Steve Appleby, Huy Trong Nguyen, Helene Houle, Jagat Narula, Douglas Wallace, Margaret Knoll, Mani A. Vannan, University of California Irvine, Irvine, CA

**Background:** Apical torsion determines optimal pump ejection. *Diogenes* is a novel angle-independent (unlike TDI) algorithm which utilizes high frame rate (FR) B-mode images and automated myocardial tracking to yield velocity vector and deformation data. We tested *Diogenes* in Wild Type (WT) and *Ant1* mutant mice with mitochondrial cardiomyopathy (CMP).

**Methods:** 14 mice (7 CMP and 7 WT) were imaged with 15L8 (8-15 MHz) linear probe on Acuson Sequoia™ (Siemens). SAX views of the apex were obtained at a FR of ~110 Hz. The endocardial border was traced over one arbitrary frame and was then automatically tracked over time with *Diogenes* (Amid, Italy & Siemens, USA). Mice were sacrificed and histology was done on the hearts.

**Results:** EF was 66±3 % in control and 36±5 % in CMP-confirmed on histology (p<0.001). A total 553 frames (14 mice) were divided into 6636 regions of which 6166 regions (92.9%) were automatically tracked. Dysynchrony(4.3±6 Vs. 47.1±9 ms, controls Vs. CMP, p<0.001) and decreased amplitude (1.0±0.4 Vs. 0.5±0.3 cm/s, p<0.001) was noted between medial and lateral apical regions in B-Mode vectoy display, M-mode maps and 3-D spatial display. Apical twist measured as peak strain and strain rate was -2.1±1.1 Vs. -1.3±0.7, and 0.8±0.3/s Vs. 0.3±0.2/s, p<0.001, see fig.

**Conclusions:** Apical twist is reduced and dysynchronous in this *transgenic* mice model of CMP. Apical torsion can be measured by angle-independent *Diogenes* utilizing high FR B-mode images to automatically track myocardium.



**1167-76 Exaggerated Differences Between Subendocardial and Mural Strain Rate in the Septum Are Clues to the Helical Structure of the Heart**

Ikuo Hashimoto, Aarti Hejmadi Bhat, Xiaokui Li, David J. Sahn, Oregon Health & Science University, Portland, OR

**Background:** The Torrent-Guasp double-helix heart muscle fiber orientation theory links embryonic development to the presence in the left ventricle (LV) of an inner descending and outer ascending myocardial band that overlap and cross each other in the septum and contribute to apex to base shortening and the spiral components of contraction.

**Methods:** Strain rate (SR) imaging studies were performed in 8 open chest pigs from short axis and apical views, analyzing SR in subendocardial (subendo) and mid mural (mid) layers of the septum and LV free wall. Mid septal bright stripe was used as the boundary between the subendo and the mid septal zone and LV dP/dt was measured concurrently. Sampling was performed over 2 x 2 mm areas on images developed with minimal spatial and temporal averaging. Meticulous tissue tracking was used to keep the sample over the same area of muscle.

**Results:** For both radial SR during isovolumic contraction (ICT) and peak systolic SR, differences between phases were greater between subendo and mid layers in the septum (ICT: septal difference, 3.31 s<sup>-1</sup> vs. free wall difference, 1.13 s<sup>-1</sup> ± 0.24 s<sup>-1</sup>, systole: 5.05 s<sup>-1</sup> vs. 4.15 s<sup>-1</sup> ± 0.19 s<sup>-1</sup>, p<0.01), and there was a difference between subendo and mid layers for peak longitudinal strain imaged from the apex, as well as a difference in SR timing. Also, subendo SR during ICT bore a closer relationship to peak positive dP/dt (r = 0.86, p<0.01).

**Conclusions:** Advances in SRI may verify aspects of the Torrent-Guasp hypothesis.



**1167-77 A New Intracardiac Ultrasound Imaging System With High Resolution, High Frame Rate Motion Mapping and EP Recording Capability**

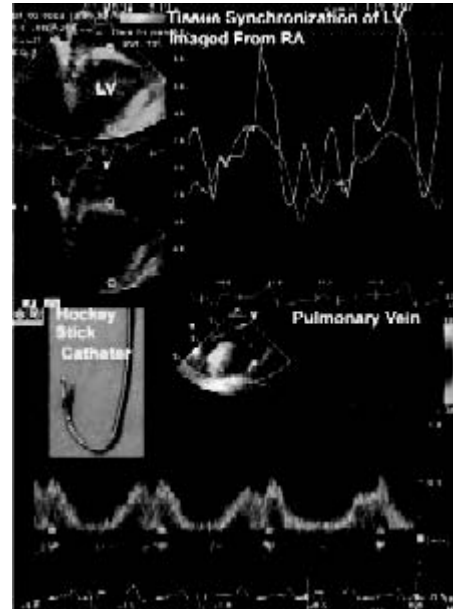
Aaron Dentinger, Kai Thomenius, K. Kirk Shung, Jonathan Cannata, Raymond Chia, Douglas N. Stephens, Xunchang Chen, Matthew O'Donnell, Crispin H. Davies, James Pemberton, Grant H. Burch, Seshadri Balaji, David J. Sahn, Oregon Health & Science University, Portland, OR, University of Michigan, Ann Arbor, MI

**Background:** This paper reports first animal tests with a 9 French, 8-13 MHz side-looking 64-element array technology developed by our Biomedical Research Partnership Grant. The catheters are fabricated by Irvine Biomedical and are steerable, much like EP catheters, and enabled for EP recording with 2 to 6 electrodes.

**Methods:** Six open-chest pigs were studied during pacing studies to simulate arrhythmias and EP procedures with the catheter running on a GE VingMed Vivid 7 system.

**Results:** High frame rate myocardial imaging and tissue Doppler strain rate allow a mechanical survey of the effects of electrical activation and shorten the ability to detect early contraction in the area of the heart that moves first on tissue tracking for high frame rate strain recording. Transatrial puncture and imaging of pulmonary veins is likewise facilitated by this high-resolution technique.

**Conclusions:** The next generation probes now being fabricated will incorporate ablational electrodes, isolated enough from the ultrasound section of the device to allow intracardiac with imaging of ablations performed using the same catheter as used for the imaging.



**1167-78 Tracking Tissue Torsion by Tissue Doppler Based Strain Rate Imaging and a New Speckle Tracking 2D Strain/Motion Analysis Program: An In Vitro Study**

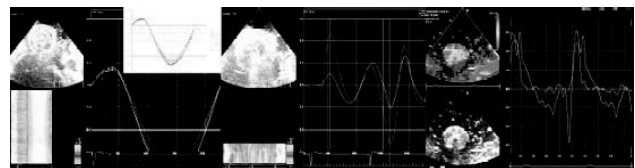
Muhammad Ashraf, Monica T. Young, Amarek J. Jensen, James Pemberton, David J. Sahn, Oregon Health & Science University, Portland, OR

**Background:** Normal LV contraction involves a twisting component, the unwinding of which is an important contribution to early diastolic filling.

**Methods:** We used a variable speed motor to rotate a thin plastic rod in a water bath. A continuous layer of beef was wrapped around this rod as a twist phantom. Tension in the roll increased slightly during rotation. Short axis 2D and tissue Doppler images were acquired using a GE/VingMed Vivid 7 at 3.5 MHz and >100frames/sec. Seven different speeds (20-80 cycles/min of winding and unwinding) were studied at two angles of rotation (45° & 90°). Data was analyzed offline on EchoPac® for tissue Doppler based strain and a new 2D strain rate (2DSR) program embedded in EchoPac®.

**Results:** The 2DSR program tracked torsion well at 45° (mean determination = 49.4° ± 2.2°[SE]), while it underestimated the 90° twist computation (mean = 68.6° ± 15.5°), more at the highest twist rates. Tissue Doppler based SRI could not effectively define twist consistently. An inner to outer deformation gradient during twisting could be detected by tissue Doppler based SRI but clearer, less noisy determinations for this gradient were computed by the 2DSR method.

**Conclusions:** The 2DSR program was more effective for detecting twist, especially because targets move across the sector, crossing scan lines of differing resolution during rotational movement.



POSTER SESSION

Table 1

**1168 Diagnosis in Chronic Coronary Artery Disease**

Tuesday, March 08, 2005, 1:30 p.m.-5:00 p.m.  
Orange County Convention Center, Hall E1  
Presentation Hour: 2:30 p.m.-3:30 p.m.

**1168-63 Fragmented QRS including RSR Complex Not Related To Bundle Branch Block Strongly Predicts Abnormal Myocardial Perfusion and Function by SPECT**

Bilal Khan, Mithlesh K. Das, Awaneesh Kumar, Sheri Stricker, Stephen G. Sawada, Jo Mahenthiran, Krannert Institute of Cardiology, Indianapolis, IN

**Background:** Fragmented QRS (fQRS) complexes, not related to typical bundle branch block (BBB) predicts abnormally delayed myocardial depolarization and function. We, therefore, postulate that fQRS is associated with significant perfusion and function abnormalities on myocardial perfusion imaging (MPI) by gated SPECT.

**Methods:** Baseline EKG and MPI of 248 patients (pts) were studied. Independent observers blinded to clinical data evaluated the EKG and MPI. The fQRS was defined by a QRS (duration  $\leq 120$  ms) with more than one R' prime or other RSR' variants (figure) in  $\geq 2$  leads corresponding to a coronary artery territory. MPI perfusion, sum motion score and ejection fraction was analyzed using a standard 17-segment, 5-point scale. MPI scar was defined by a single segment and sum rest score  $\geq 3$  and a sum difference score  $\leq 3$  corresponding to individual coronary territory.

**Results:** In 237 pts (mean age  $58 \pm 12$  years, 128 [54%] males), 108 (45%) pts had fQRS complexes (11 pts were excluded due to BBB or paced rhythm). MPI findings summarized on the table (figure). There was significant correlation of a fQRS to an underlying MPI scar ( $r=0.65$ ,  $p<0.001$ ) in 89 of 108 (82%) pts. On logistic regression, resting systolic blood pressure ( $p=0.007$ , RR: 0.95) and the presence of myocardial scar by MPI ( $p<0.001$ , RR: 29.5) were significant predictors of fQRS on EKG.

**Conclusions:** An fQRS complex including RSR' patterns, in the absence of typical BBB, is a significant predictor of regional myocardial scar and reduced ejection fraction by MPI.

**Fragmented QRS including RSR' morphology and its variants**



MPI variables	fQRS (n=108)	No fQRS (n=129)	p-value
Sum stress score	10 ± 10	4.8 ± 5.0	<0.0001
Sum rest score	8 ± 9	2 ± 3.5	<0.0001
Sum difference score	2.3 ± 3	1 ± 2	<0.0001
Sum motion score	7.8 ± 8.8	1 ± 3.6	<0.0001
MPI Ejection Fraction	50 ± 14	63 ± 10	<0.0001
MPI myocardial scar	89 (82%)	16 (12%)	<0.0001

**1168-64 Erectile Dysfunction Predicts Clinically Significant Coronary Artery Disease in Men Referred For Myocardial Perfusion SPECT Testing**

James K. Min, Tochi M. Okwuosa, George W. Bell, Michael S. Panutich, Nami Choe, Kim A. Williams, R. Parker Ward, University of Chicago Hospitals, Chicago, IL

**Background:** Erectile dysfunction (ED) is associated with coronary artery disease (CAD) risk factors, but the association between ED and CAD is unknown. Myocardial perfusion SPECT (MPS) imaging allows detection of CAD and predicts cardiovascular (CV) prognosis. We hypothesized that ED is associated with CAD as determined by MPS testing.

**Methods:** 167 male patients (pts) referred for MPS testing were prospectively screened for ED. CV comorbidities and medications were recorded. ED was defined by a score of  $< 25$  on the validated international index of erectile function (IIEF). CAD was defined as mild [summed stress score (SSS)  $\geq 4$ ] or severe (SSS  $\geq 8$ ).

**Results:** ED was present in 56% of pts. ED pts were older, had more diabetes (DM), hypertension (HTN), beta blocker use and other antihypertensive use. ED was associated with more referrals for pharmacologic MPS testing, and more CAD (See Table 1). Among pts referred for exercise, ED was associated with lower exercise time and Duke treadmill score (DTS). Multivariate analysis considering CV risk factors and medication use found ED to be an independent predictor of severe CAD (OR 3.2, 95% CI 1.4-7.1,  $p<0.01$ ). ED absence is associated with a high negative predictive value for severe CAD (85%).

**Conclusions:** ED is common in men referred for MPS testing and is associated with adverse prognostic indicators including lower exercise time, lower DTS, and more mild and severe CAD. Further study is needed to determine if all pts with ED benefit from screening for CAD with MPS testing.

	ED	NO ED	P value
Exercise	50%	77%	<0.001
Exercise Time (min)	8.0	10.2	<0.001
Total MET	9.2	11.6	<0.001
DTS	4	9	<0.001
SSS $\geq 4$	55%	38%	0.030
SSS $\geq 8$	41%	15%	<0.001

**1168-65 Association Between Plasma Myeloperoxidase Levels and Ischemic Response During Stress Nuclear Perfusion Imaging**

Hamid Ghanbari, Bischan Hassunizadeh, Frances Williams, Denise Cunningham, Shivani Agrawal, Christian Machado, Souheil Saba, Providence Hospital and Medical Centers, Southfield, MI

**Background:** Myeloperoxidase (MPO) is an abundant enzyme secreted from monocytes, neutrophils, and tissue macrophages. Elevated MPO levels correlate with an increased risk of future major cardiac events in patients with chest pain and are found in patients with angiographically documented cardiovascular disease.

**Objective:** The objective of this study was to determine if plasma MPO levels measured by Enzyme Immuno Assay (EIA) correlate with the detection of myocardial ischemia in patients undergoing stress myocardial perfusion imaging (MPI).

**Methods:** Patients undergoing MPI and patients that had recent positive MPI referred for cardiac catheterization were included in the study. Patients with evidence of inflammatory disease by history or abnormal differential blood count and patients with previous myocardial infarction were excluded. Five milliliters of heparinized plasma was analyzed by EIA (Assay Designs, Inc) using human MPO antibody and the MPO levels were determined photometrically.

**Results:** The study comprised of 83 patients. Mean age was 63 years. In control group, 32 patients had a negative MPI (Group 1). Positive MPI was noted in 29 patients, of which 17 had significant stenosis  $\geq 70\%$  on subsequent coronary angiogram (Group 2, true positives) and the remaining 12 had non-critical CAD or normal coronaries (Group 3, false positives). Patients in Group 1 had a significantly higher mean MPO level ( $215 \pm 22$  pM) compared to patients in Group 3 ( $118 \pm 20.9$ ,  $p=0.02$ ). Patients in Group 2 had a significantly higher mean MPO level ( $320 \pm 62.6$ ) than patients in Group 3 ( $p=0.006$ ). Group 2 had a higher MPO level than Group 1, but the difference was not statistically significant ( $p=NS$ ). Patients who were obese with BMI  $> 30$  had a higher mean MPO level ( $248 \pm 28.7$  pM) than patients with BMI  $< 30$  ( $124 \pm 20.6$  pM,  $p=0.001$ ).

**Conclusion:** 1) Patients with a true positive MPI and confirmed critical CAD on coronary angiogram (Group 2) have significantly higher MPO levels than patients who have false positive MPI studies (Group 3). MPO levels may help in differentiating true positive from false positive MPI results.

2) Patients with obesity (BMI  $> 30$ ) have a significantly higher level of MPO than non-obese patients.

**1168-66 Significance of Changes in Left Ventricular Cavity Size in Dipyridamole Stress Rubidium-82 Myocardial Perfusion PET**

Timothy M. Bateman, A. Iain McGhie, Gary V. Heller, Kelly L. Moutray, Ginger Hertenstein, Jan R. Bryngelson, Kevin W. Moser, S. James Cullom, James A. Case, John D. Friedman, Cardiovascular Imaging Technologies, Kansas City, MO, Mid America Heart Institute, Kansas City, MO

**Background:** Transient ischemic dilation (TID) of the left ventricle in stress SPECT imaging correlates with extensive coronary artery disease (CAD) and a worse prognosis. Dipyridamole myocardial perfusion PET scans are acquired at the peak of hyperemia, not post-stress as with SPECT. We therefore hypothesized that this non-perfusion marker would carry greater diagnostic significance when it occurs with PET imaging.

**Methods:** The current investigation evaluates TID in 123 rest-stress dipyridamole Rb-82 PET scans of patients who had either low likelihood for significant CAD ( $n=33$ ) or who had coronary angiography  $< 60$  days ( $7 =$  no CAD  $\geq 50\%$  stenosis,  $22 =$  single-vessel (SV) CAD,  $61 =$  multivessel CAD). Images were acquired using an ACCEL (CTI, Knoxville, TN) LSO dedicated PET scanner in 2D mode. The presence or absence of TID was assessed visually by consensus of 4 interpreters blinded to all clinical information. Quantitative TID was also computed using a commercially-available computer program (QGS®; Cedars-Sinai, LA, CA).

**Results:** By visual analysis, TID was present in 0/40 patients without CAD, 32% of pts with single-vessel CAD ( $p<0.001$  vs no CAD), and 39% of pts with multivessel (MV) CAD ( $p<0.001$  vs no CAD;  $p=ns$  vs SV CAD). Sensitivity and specificity of visual TID for any CAD were 37% and 100% and for MV CAD were 39% and 85%. By quantitative analysis, mean TID ratio ranged from  $1.1 \pm 0.1$  for pts without CAD to  $1.3 \pm 0.2$  for those with MV CAD ( $p=0.02$ ). Using 1.2 as a cut-off criteria for abnormality yielded sensitivity and specificity of 46% and 73% for any CAD. The mean summed difference score (17 segment model, scores 0 - 3 per segment) was  $5.5 \pm 6.8$  for those without TID, versus  $11.1 \pm 10.4$  for those with TID ( $p=0.0003$ ). There were no gender differences for any comparisons. Addition of TID to perfusion defect analysis improved PET sensitivity from 84% to 89% ( $p<0.05$ ) with no change in specificity (100% to 98%).

**Conclusions:** Transient ischemic dilation in response to image acquisition during dipyridamole-induced hyperemic stress Rb-82 PET is a highly specific marker of CAD, is frequent in both single and multivessel CAD, and modestly improves diagnostic sensitivity above perfusion defect analysis alone.

**1168-67 Left Ventricular Dysfunction After Vasodilator Stress Is More Accurate Than Perfusion for Diagnosis of Coronary Artery Disease**

Regina S. Druz, Kenneth J. Nichols, Olakunle O. Akinboboye, Nathaniel Reichel, St. Francis Hospital, Stony Brook University, State University of New York, Roslyn, NY, Long Island Jewish Medical Center, New Hyde Park, NY

**Background:** Three-vessel coronary disease (3VD) is difficult to detect by perfusion imaging due to balanced ischemia. We hypothesized that post-stress left ventricular (LV) dysfunction should more accurately identify 3VD.

**Methods:** 86 pts. (74±12 y; 58 male) with rest TI-201/adenosine Tc-99m sestamibi scans were identified: 43 with known/suspected coronary stenoses with ≥ 1 segmental reversible defect, and 43 age- and sex-matched controls with no coronary disease and normal LV perfusion and function. Perfusion was based on a 20-segment/5-point summed difference score (SDS), with ≥ 8 cut-off for extensive defects. Segments with no tracer uptake were excluded to lessen partial volume effects. LV ejection fraction (EF) and end-systolic volume (ESV) were quantified at rest and 60 min post-adenosine by QGS (Cedars-Sinai Medical Center, Los Angeles, CA). A cut-off for EF decrease (↓) was ≥ -12% (= 2 SD of mean EF↓ in controls: -0.9±6.0%). LV dilation ratio was measured by ESV adenosine: rest. Angiography was performed in 36/43 pts with segmental defects, and 15/36 pts had 3VD. McNemar's test (p<0.05) was used to compare SDS≥ 8 vs. EF↓ ≥ -12%.

**Results:** See Table.

**Conclusion:** LV dysfunction manifested as stunning, with decrease in LV EF and LV dilation in patients with extensive reversible defects, especially those with angina. A decrease in EF was more specific and accurate for 3VD than perfusion. Thus, gated rest and stress studies had improved diagnostic yield over perfusion.

EF ↓ ≥ -12%	Angina	SDS	ESV adenosine: rest	EF ↓ for 3 VD	SDS≥8 for 3 VD
No n=33	9%	6±5	1.3±0.2	Sensitivity 87%	Sensitivity 87%
Yes n=10	44%*	10±5*	1.7±0.3†	Specificity 82%‡	Specificity 48%
				Accuracy 83%‡	Accuracy 62%

\*p<0.05 †p<0.0001 ‡ p<0.004 vs. SDS

**1168-68 Routine Myocardial Perfusion Imaging Post Implantation of Drug Eluting Stents, Frequency of Detecting Ischemia in Asymptomatic Patients**

Randall C. Thompson, Justin L. Martin, Timothy M. Bateman, Ben D. McCallister, Barry D. Rutherford, Mid America Heart Institute, Kansas City, MO

**Introduction:** Patients who have had percutaneous coronary intervention (PCI) historically have often been referred for myocardial perfusion imaging (MPI) because of a relatively high prevalence of recurrent myocardial ischemia. However, restenosis occurs less frequently after drug-eluting stent (DES) implantation, and it is not clear whether follow-up algorithms involving liberal use of MPI are appropriate in the current era.

**Methods:** We reviewed the findings on MPI in all asymptomatic or minimally symptomatic post-DES patients at our center (n=168) who were tested electively at 3 - 12 months after DES-PCI and compared the results with those of similar patients who had routine MPI after bare metal stents (BMS) (n=681). Patients were not included if they had more than mild symptoms. Ischemia was defined as a summed difference score > 3 on 20 segment, 0-4 grade scale.

**Results:** The mean interval from PCI to MPI was 5.1 ± 1.8 mo & 5.8 ± 2.7 for the DES and BMS groups respectively. Mean age (64.6 ± 11.9 & 64.7 ± 12), sex (69% & 67% male), and diabetics (20.7% & 19.3%) were similar, but the DES group received more stents (mean 1.9±1 vs 1.7±1) (p=.02), more total stent length 31.6± 18 vs 28± 17.2 mm (p=.018) with a smaller mean stent diameter (2.9± .03 vs 3.3± .5 mm) (p<.001), and a trend toward more multivessel CAD (74.4 vs 64.6%) (p=.06) On MPI, some ischemia was common in both groups, occurring in 61.5% and 63%, but was frequently mild. However, target vessel ischemia more than mild occurred in 25.2% and 25.9% (p=ns), and significant ischemia (summed difference score ≥ 8) was seen in 29.8% and 30.7% (p=ns).

**Conclusions:** In this population of patients post DES implantation, MPI done for routine follow-up detected clinically significant silent ischemia in 30% of patients. Ischemia post DES-MPI was as common as in the post BMS-PCI group, probably related to an increase in the complexity of the coronary disease being treated. These data support a policy of liberal MPI testing post DES-MPI, despite the low rate of restenosis seen in clinical trials.

**1168-69 Chest Discomfort Does Not Predict Abnormal Rubidium-82 Positron Emission Tomography Results or Mortality in Non-Diabetic Patients with Chronic Kidney Disease**

Mark Anthony Stankewicz, Amar D. Patel, Robert L. Eisner, Randolph E. Patterson, Carlyle Fraser Heart Center, Emory-Crawford Long Hospital, Atlanta, GA, Emory University School of Medicine, Atlanta, GA

**Background:** Chest discomfort (CP) and coronary artery disease (CAD) are common in chronic kidney disease (CKD) patients, and CP is a common indication for myocardial perfusion imaging (MPI). However, the reliability of CP to predict CAD in CKD patients has not been studied in detail. We examined the reliability of CP to predict rubidium-82 positron emission tomography (PET) MPI results and mortality rate.

**Methods:** All CKD patients having cardiac PET-MPI from 1999-2003 were identified, and diabetics were excluded. Patients were grouped based on features of CP: chest pain onset with exertion, duration of 2-30 minutes and location in the retrosternal position. One of three features defined non-anginal CP, two features defined atypical angina,

and CKD patients with three features (classic angina) did not have PET-MPI. All cause mortality was determined by using the Social Security database and hospital records. Continuous variables were compared using the student t-test and categorical variables were compared with chi-squared (Yates) analysis (SPSS). A p-value of <0.05 was defined as statistically significant.

**Results:** 230 CKD patients with a mean creatinine of 7.73 mg/dL had cardiac PET-MPI during the 48 month study period. There were 115 women (50%), 172 African-Americans (83%), and the mean age was 58.5 years (29-89 years). Mortality was 31% over the average 24.2 month follow-up period. CP was present in 71% of patients, defined as non-anginal (50%) or atypical anginal CP (21% of all patients). CP patients used tobacco more frequently (59% vs 39%, p=0.04), and were more likely to report a family history of CAD (59% vs 18%, p<0.001). Abnormal PET results occurred with equal frequency among patients with the following: no CP (27%), non-anginal CP (28%), or atypical angina (28%, p=ns). Mortality rates were also similar among these same groups (27%, 28%, 37%, p=ns).

**Conclusions:** CP did not predict abnormal PET-MPI or increased mortality in CKD patients, even after excluding diabetics. In this study, CP history appears to have limited value to predict ischemic heart disease or mortality in CKD patients.

**1168-70 Gender and Racial Differences in the Specificity of Exercise Induced ST Segment Depression**

Sabahat Bokhari, Lynne Johnson, Steven Robert Bergmann, Simbo Chidiaka, Columbia University Medical Center/ New York Presbyterian Hospital, New York, NY

**Objective:** It is not known whether racial differences affect the specificity of ST segment depression during treadmill exercise stress testing. Therefore, we examined the incidence of exercise induced ST segment depression among Caucasians (C) and African Americans (AA) who underwent exercise treadmill testing with the standard Bruce protocol and had normal myocardial perfusion imaging.

**Methods:** We evaluated 338 patients, 186 C (97M, mean age 60 ± 12 years) and 152 AA (57M, mean age 55 ± 12 years, (p = 0.001). There was no significant difference in 10 year CAD risk using Framingham risk score among C (12 ± 8) and AA (12 ± 9) p = NS. Standard ST segment depression criteria as defined by the ACC/AHA guidelines were used.

**Results:** Percent predicted maximum heart rate was higher in C (94% ± 11) vs that for AA (90% ± 11) p < 0.006. Mean exercise time was longer in C (8.3 ± 2.9 mins) as compared with AA (7.5 ± 2.5 mins), p = 0.01. Overall, the incidence of false positive ST segment depression was 26/186 (14%) among C, and 9/152 (6%) among AA, p = 0.01. The incidence of false positive ST segment depression was 13/97 (13%) in C males, and 4/57 (7%) in AA males, p=NS. The incidence of false positive ST segment depression was 13/98 (15%) in C females, as compared with 5/95 (5%) in AA females, p=0.05. Thus the specificity of ST segment depression was 87% in C males compared with 93% in AA males, and 85% in C females compared with 95% in AA females. **Conclusion:** Our study shows that there was a significantly higher incidence of false positive ST segment changes in Caucasians females as compared to African Americans females. There may be a need for race and gender specific criteria for ST segment changes during exercise stress testing.

ORAL CONTRIBUTIONS

**855 Real-Time Three-Dimensional Echocardiographic Assessment of Chamber Function**

Tuesday, March 08, 2005, 2:00 p.m.-3:30 p.m.  
Orange County Convention Center, Room 232A

2:00 p.m.

**855-3 Partition Values for Normal Left and Right Ventricular Volumes by Three-Dimensional Echocardiography**

Sunil T. Mathew, Aasha S. Gopal, Rupa R. Krishnaswamy, Rena S. Toole, William Schapiro, Nathaniel Reichel, St. Francis Hospital, Roslyn, NY, Stony Brook University, Stony Brook, NY

**Background:** Live three-dimensional echocardiography (3D echo) for acquisition of volumetric data utilizing 4 ECG gated sequential scan sets (Philips 7500) is widely available, but normal values for chamber volumes have not been determined. We obtained left (LV) and right ventricular (RV) end-diastolic (EDV) and end-systolic (ESV) volumes by 3D echo and cardiac magnetic resonance imaging (CMR).

**Methods:** 31 normal subjects (ages 21-76 yrs, mean 56.6 yrs, 21 men, BSA 1.9±0.2 m<sup>2</sup> screened by history, physical examination and 2D echo for cardiac abnormalities were imaged using a) 3D echo by an approximating surface model (TomTec) from 8 rotationally equidistant apical slices, and b) CMR (1.5 T Siemens) using contiguous, short axis, ECG gated, breath-hold, TrueFISP cine images (146 x 256 matrix, 8 mm slice thickness, 31 x 38 cm FOV). Echocardiographic results were compared to CMR using Pearson's correlation, linear regression, and Bland-Altman analysis.

## Results:

Partition Values for Normal and Abnormal  
LV and RV Volumes and EF

	Mean(ml)	2SD(ml)	r	SEE (ml)	Regression	p	Bias	Lower limits (ml)	Upper limits (ml)
3DLVEDV(ml)	128	42	0.95	6.5	y=0.8x+27	<0.0001	3	-13	19
3DLVEDV(ml/m <sup>2</sup> )	69	18	0.94	3.3	y=0.8x+17	<0.0001	1.7	-6	10
3DLVESV(ml)	54	24	0.88	5.6	y=0.7x+17	<0.0001	1.2	-12	14
3DLVESV(ml/m <sup>2</sup> )	29	10	0.82	3.1	y=0.7x+10	<0.0001	0.7	-7	8
3DRVEDV(ml)	112	58	0.84	16.1	y=0.7x+9	<0.0001	-27	-62	8
3DRVEDV(ml/m <sup>2</sup> )	60	27	0.76	8.9	y=0.7x+5	<0.0001	-14	-33	4
3DRVESV(ml)	59	38	0.83	11	y=0.7x+7	<0.0001	-15	-40	10
3DRVESV(ml/m <sup>2</sup> )	31	18	0.77	5.7	y=0.7x+5	<0.0001	-8	-21	5

**Conclusions:** 1) 3D echo LV EDV and ESV indexed values of 86 ml/m<sup>2</sup> and 39 ml/m<sup>2</sup> are 2 SD from the normal mean and should be considered abnormal. 2) Excellent agreement is noted between 3D echo and CMR. 3) RV volumes are underestimated by 3D echo and may be corrected by regression. 3D echo RV EDV and ESV values of 87 ml/m<sup>2</sup> and 49 ml/m<sup>2</sup> are abnormal. 4) Further work is necessary to determine age and gender effects on normal values and clinical utility must be demonstrated in abnormal ventricles.

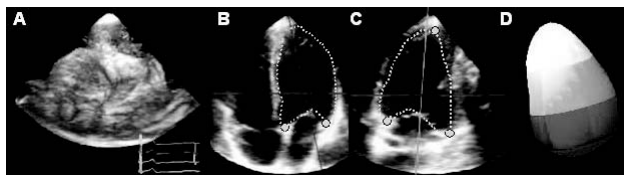
2:15 p.m.

855-4

### Real-Time Three-Dimensional Echocardiographic Quantification of Left Ventricular Volumes Using a Rapid Tissue Tracking Algorithm

Lawrence Jacobs, Ivan S. Salgo, Sascha Goonewardena, Lissa Sugeng, Lynn Weinert, Patrick D. Coon, Dianna Bardo, Olivier Gerard, Eran Toledo, Cristiana Corsi, Victor Mor-Avi, Roberto M. Lang, University of Chicago, Chicago, IL, Philips Medical Systems, Andover, MA

Determination of LV volumes and ejection fraction (EF) from 2D images is limited due to the extrapolation of manually or semi-automatically traced endocardial borders and geometric modeling. This methodology is subjective, time-consuming and relatively inaccurate. Our aim was to develop a method for rapid measurement of LV volumes from real-time three-dimensional (RT3D) data and validate it against cardiac MRI. **Methods.** Cardiac MRI (GE, 1.5T FIESTA, 6-10 slices base to apex) and apical wide-angle RT3D data sets (fig. A) were obtained in 23 patients (Philips 7500, X4 probe). Prototype software (3DQ Advanced) was used for analysis of 3D data. Following manual initialization of 5 points on 2 non-foreshortened, anatomically correct orthogonal long-axis views extracted from the 3D data sets (figs. B, C), endocardial surface was detected using a deformable model by tracking tissue voxels (fig. D). End-systolic and end-diastolic volumes (ESV and EDV) were computed directly from voxel counts. Data were compared with MRI (GE, MASS analysis) using linear regression and Bland Altman analyses. **Results.** Generating one LV volume from RT3D required <1min including initialization. RT3D measurements correlated highly with MRI (r: 0.93, 0.94, 0.83 for EDV, ESV and EF, respectively) with small biases (-9 ml, -4 ml, -0.4%) and narrow limits of agreement (SD: 16 ml, 16 ml, 9%). **Conclusions.** Near-automated detection of the LV endocardial surface from RT3D data allows rapid, accurate, direct measurement of LV volumes.



2:30 p.m.

855-5

### New Real-time 3D Echocardiography Provides Accurate Measurement of Left Ventricular Mass in Patients With Left Ventricular Hypertrophy

Hiroki Oe, Takeshi Hozumi, Yoshiki Matsumura, Kotaro Arai, Kazuaki Negishi, Kenichi Sugioaka, Ujino Keiji, Yasuhiko Takemoto, Yuichi Inoue, Junichi Yoshikawa, Osaka City University Medical School, Osaka, Japan

**Background:** Measurement of left ventricular (LV) mass is important for the evaluation of LV hypertrophy, and provides prognostic information. The purpose of this study was to evaluate whether LV mass assessed by the new real-time 3D echocardiography (RT-3DE) system corresponds to cardiac magnetic resonance imaging (MRI) in patients (pts) with LV hypertrophy (LVH).

**Methods:** The study population consisted of 22 pts (53 ± 14 years) who underwent MRI for the evaluation of LVH. All the pts were examined by RT-3DE (Philips Sonos 7500) and two-dimensional echocardiography (2DE) for calculating LV mass. The apical approach was used to acquire full volume volumetric data sets of the LV. LV mass was calculated by the average rotation method with 8 apical cross-sectional images, using 3D imaging analyzer (Tomtec). In 2DE, LV mass were calculated with the area-length methods.

**Results:** In 20 of 22 pts, it was possible to obtain adequate 3D data for LV mass analysis. The acquisition time of the 3D data by RT-3DE was shorter than cardiac MR data acquisition (<10 seconds vs 10-15 minutes). Regression analysis showed LV mass by RT-3DE correlated well with LV mass determined by MRI (r=0.95, y=28.9-0.85x). Mean difference of LV mass between RT-3DE and MRI was -14.1. The correlation between LV mass determined by 2DE and MRI-derived LV mass was smaller than that between RT-

3DE and MRI (r=0.70, y =43.6+0.81x). Mean difference of LV mass between 2DE and MRI was -10.7. With the RT-3DE, intra- and inter-observer variability for LV mass was 7.6% and 10.6%. With the 2DE, intra- and inter-observer variability for LV mass was 21.5% and 27.0%.

**Conclusion:** The new RT-3DE system allows accurate measurement of LV mass in pts with LVH. The present study suggests that greater accuracy and reproducibility of 3D techniques by new RT-3DE for LV mass measurement has important implications for clinical practice.

2:45 p.m.

855-6

### New Observations in Use of Live 3-D Echo during 2-D Dobutamine Stress Echocardiography; the Impact of Contrast Enhancement and Evaluation of the Extent of Ischemia

Masood Ahmad, Zening Jin, Tianrong Xie, William Hendrix, Ildiko Agoston, Meneleo Dimaano, Frank Tiller, Jr., Fen Wei Wang, University of Texas Medical Branch at Galveston, Galveston, TX

**Background:** We recently reported the complimentary role of Live 3-D echocardiography (3-D Philips Medical Systems) in patients (pts) undergoing 2-D Dobutamine stress echocardiography (DSE). The present study extends our observations in a larger group of pts and includes the use of contrast for LV visualization and the evaluation of the extent of ischemia by 3-D.

**Methods:** Two hundred and sixty-six pts, age range 30 - 89 yrs were studied. All pts had 2-D DSE. 3-D bi-plane and full volume images were obtained in parasternal and apical views at baseline and at peak stress by rapidly switching transducers between 2-D and 3-D techniques. Intravenous contrast (Definity or Optison) was used in 189 pts with suboptimal image quality at baseline. Cropping planes were applied on-line to slice images for visualization of LV segments in multiple planes. LV wall motion was assessed in 3-D from serial short axis slices obtained from apex to base. 2-D and 3-D images were evaluated by two different observers.

**Results:** Technically satisfactory 3-D images for comparison with 2-D were obtained in all 266 pts. Based on the presence or absence of normal or abnormal LV wall motion at baseline and on the presence or absence of ischemia at peak stress, the agreements between 2-D and 3-D were 95.5% (Kappa (K) = 0.80) at baseline and 92.5% (K = 0.78) at peak stress. In 179 pts with contrast, the agreements were 95% (K = 0.72) at baseline and 92.3% (K = 0.77) at peak stress and in 87 pts without contrast, the agreements were 96.6% (K = 0.85) at baseline and 93% (K = 0.81) at peak stress. The mean LV wall motion score at peak stress in 58 pts with ischemia by 3-D was 1.34 ± 0.30 compared to 1.28 ± 0.35 by 2-D (p = 0.01). In 89 pts with coronary angiograms, the sensitivity of 3-D in detection of coronary artery disease was 84% compared to 69.6% by 2-D (p < 0.05).

**Conclusions:** Technically satisfactory 3-D stress images were obtained in all pts by selective contrast enhancement. There was good overall agreement between 3-D and 2-D in assessment of ischemia. 3-D had higher sensitivity and detected a greater number of ischemic segments when compared to 2-D. The visualization of LV from multiple vantage points by 3-D offers advantages in estimating the extent of ischemia.

3:00 p.m.

855-7

### Can Quantification of Left Ventricular Mechanical Dyssynchrony by Real-time 3d Echo Predict Reverse Left Ventricular Remodelling Following Cardiac Resynchronisation Therapy?

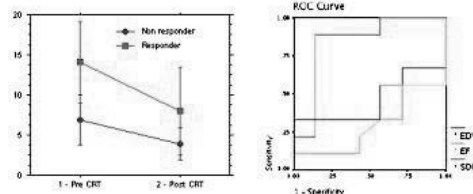
Stamatis Kapetanakis, Mark Kearney, Nicholas Gall, Francis Murgatroyd, Mark John Monaghan, King's College Hospital, London, United Kingdom

**Background:** Left ventricular mechanical dyssynchrony (LVMD) has emerged as a possible predictor of outcome following cardiac resynchronisation therapy (CRT). We investigated the value of Real-Time 3D echo (RT3DE) in quantifying LVMD in patient undergoing CRT.

**Methods:** 2D and RT3D echo was performed in 26 patients (67.5±6.1 years, 86% male) pre, at 2±1 days and at 10±1 months post CRT. Biplane EF, SPWMD and myocardial performance index (MPI) was calculated by 2D and Doppler echo. RT3D data sets were analysed offline to produce time-volume curves for each of the standard 16 segments and a Systolic Dyssynchrony Index (SDI) was calculated based on dispersion of times to minimum regional volume for all segments. Reverse remodelling was defined as a reduction in LV end-diastolic volume of 20% or more.

**Results:** 16 patients were re-investigated at 10±1 months. 3 patients (11.3%) reported no symptomatic improvement 2 months post CRT, while all other patients reported a decrease in NYHA class. In these, the SDI pre CRT was significantly higher (13.9±5.3 vs. 6.1±3.1, p = 0.019) and was the only predictor of symptomatic improvement in multivariate analysis. At 10±1 months, reverse remodelling was present in 9 patients. SDI pre CRT was the strongest predictor with an AUC of 0.84 (p = 0.023). An SDI of 9.2% had a sensitivity of 88.9% and a specificity of 86.7% for reverse remodelling post CRT.

**Conclusion:** Symptomatic improvement post CRT and reverse LV remodelling was predicted by RT3DE. This may be useful in patient selection for CRT.



3:15 p.m.

4:15 p.m.

**855-8 Electroanatomic (Carto) Mapping for Evaluating Left Atrial Volume: Validation Against Real-Time 3-D Echocardiography**

Haran Burri, Hajo Müller, Henri Sunthorn, Pascale Gentil, René Lerch, Dipen Shah, University Hospital, Geneva, Switzerland

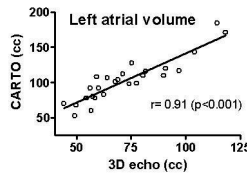
**Background:** Left atrial size may be a determinant of atrial fibrillation ablation efficacy and embolic risk. Electro-anatomic (CARTO) mapping allows estimation of chamber volume, but has never been validated for measuring left atrial size. The recent advent of real-time 3D echocardiography allows measurement of chamber volumes more accurately than with standard echocardiography.

**Aim:** To compare left atrial volume measured using CARTO with that measured by real-time 3D echocardiography.

**Methods:** 26 patients undergoing CARTO-guided radiofrequency ablation for atrial fibrillation or left atrial flutter were studied, and left atrial volume measured by mapping 73±17 points. Full-volume real-time 3-D echocardiography was performed within 24 hours in each patient, and end-systolic left atrial volume measured offline.

**Results:** Left atrial volume measured using CARTO correlated very well with that using 3D echocardiography (see figure), but electro-anatomic mapping consistently yielded greater values (mean difference of 30±15cc).

**Conclusion:** Left atrial volume measured by CARTO correlates remarkably well with that using real-time 3D echocardiography, although the former technique consistently yields larger values.



ORAL CONTRIBUTIONS

**861 Advances in Single-Photon Emission Computed Tomography and Positron Emission Tomography for Coronary Artery Disease Diagnosis**

Tuesday, March 08, 2005, 4:00 p.m.-5:00 p.m.  
Orange County Convention Center, Room 230D

4:00 p.m.

**861-3 Combined Prone and Supine Quantification Improves Diagnostic Value of the Myocardial Perfusion SPECT**

Hidetaka Nishina, Piotr J. Slomka, Aiden Abidov, Cigdem Akincioglu, Xingping Kang, Ishac Cohen, Sean W. Hayes, John D. Friedman, Guido Germano, Daniel S. Berman, Cedars-Sinai Medical Center, Los Angeles, CA

**Background:** Acquisition in the prone position has been demonstrated to improve the accuracy of myocardial perfusion SPECT (MPS). However, the additional value of prone MPS using quantitative analysis has not been shown.

**Methods:** Separate prone and supine normal limits were derived from 40 males and 40 females with a low likelihood (LLk) of coronary artery disease (CAD) using a 2.5 average deviation cut-off. These limits were applied to 326 consecutive pts (Group 1) without known CAD who had coronary angiography within 3 months of MPS. Total perfusion deficit (TPD), defined as a product of defect extent and average severity scores, was obtained for supine (S-TPD), prone (P-TPD), and combined supine-prone datasets (C-TPD). C-TPD was derived by limiting the quantification of supine defects within overlapping prone defects. Group 1 was randomly divided into two equal groups for deriving and validating optimal cut-offs. Normalcy rates were validated in three groups of consecutive LLk pts: unselected pts (Group 2a, n=105); female pts with large breasts (Group 2b, n=108); and pts with body mass index >30 (Group 2c, n=118).

**Results:** C-TPD yielded significantly higher specificity than S-TPD for identification of CAD ≥70%, without compromising sensitivity. Normalcy rates for C-TPD were also higher than for S-TPD in groups 2b and 2c.

**Conclusions:** Combined prone-supine MPS quantification significantly improves specificity of MPS in identification of obstructive CAD compared to supine MPS alone.

	ROC areas	Sensitivity (%)	Specificity (%)	Normalcy Rate (%)		
				Group 2a	Group 2b	Group 2c
S-TPD	0.85±0.02	88	67	89	78	82
P-TPD	0.88±0.02	88	80	92	87	91
C-TPD	<b>0.89±0.02*</b>	86	<b>91*</b>	97	<b>94*</b>	<b>98*</b>

\* p < 0.02 vs. S-TPD

**861-4 Evaluation of Coronary Artery Disease (CAD) in Diabetic Patients Presenting with Dyspnea but no Chest Pain : Findings on Myocardial Perfusion Imaging (SPECT) and Coronary Angiogram (CATH)**

Su Min Chang, Regina Chu, Douglas Russell, Timothy F. Christian, University of Wisconsin, Madison, WI

**Background:** Diabetics with underlying CAD often present with dyspnea but no chest pain (CP)

**Objectives:** In diabetics with dyspnea but no CP, examine the prevalence and predictors of CAD detected as myocardial perfusion abnormality (MPA) by SPECT and angiographic coronary stenosis (CAS) (> 50 % stenosis in one major coronaries)

**Method:** 198 consecutive SPECT were performed in diabetics with dyspnea alone for suspected CAD. Used as control were 312 diabetics with CP alone. CATH were done in 44 % and 53 % of pts respectively. High risk MPA was defined as >15 % LV perfusion defect size (LVPDS), multivessel or LAD distribution. Severe CAS defined as left main, 3 VD or 2VD involving LAD

**Results:** The baseline characteristics between the 2 groups were similar. The prevalence of MPA (60 % vs 61% p =0.8), high risk MPA (44 % vs 43 % p =0.8) and LVPDS (22.7-15.6 % of LV vs 23.9 + 13.1 % p =0.6 ) were about equal. Finding on CATH was also similar. 85 % of dyspneic pts had CAS vs 88 % of pts with CP (p =0.6). The prevalence of severe CAS was identical (44 % vs 44 % p =0.9)

Univariate predictors of MPA in dyspneic pts were male, h/o MI, abnormal rest ECG and inability to exercise. Male and MPA predicted presence of CAS. ( p < 0.05) Similar predictors were found for pts with CP alone.

Independent predictors for severe CAD in both groups of pts were shown on table.

**Conclusion:** Diabetics presenting with dyspnea alone have a high likelihood of CAD, similar to those with CP alone. Age > 65, positive stress ECG and high risk MPA identified pts at high risk for severe CAS.

all P <=0.05

Diabetics with Dyspnea Alone	Odds Ratio (95% CI)	Diabetics with Chest Pain Alone	Odds Ratio (95% CI)
Severe CAS age> 65	2.8 ( 1.01 - 7.7)	Severe CAS age> 65	4.6 (1.8 -11.7)
Positive stress ECG	7.8 ( 1.55 - 40)	Male	4.8 (2.1-11)
High Risk MPA	3 (1.02 - 9.3)	High Risk MPA	4.7 ( 1.8 -12.3)
High Risk MPA h/o MI	3.5 ( 1.3 - 9.3)	High Risk MPA h/o Revascularization	4.7 (2.3 -9.9)
Abnormal rest ECG	3.4 (1.4 - 10.8)	Abnormal rest ECG	3.4 (1.7 - 6.8)
Inability to exercise	3 (1.1 - 8.1)	> 2 risk factors	3.2 (1.1 -9.1)
Positive stress ECG	4.2 ( 1.3 - 13.4)	Positive stress ECG	2.9 (1.15-7.3)

4:30 p.m.

**861-5 Attenuation Corrected Myocardial Perfusion Imaging Optimizes Detection of Left Anterior Descending Coronary Artery Stenoses in Women**

Regina S. Druz, Kenneth J. Nichols, Uzodinma R. Dim, Karen Ngai, Olakunle O. Akinboboye, Nathaniel Reichek, St. Francis Hospital, Stony Brook University, State University of New York, Roslyn, NY, Long Island Jewish Medical Center, New Hyde Park, NY

**Background:** Perfusion imaging in women is affected by anterior wall attenuation due to breast. Attenuation correction (AC) yields conflicting results. We investigated whether AC improves accuracy and diagnostic interpretation over supine uncorrected imaging for left anterior descending (LAD) stenosis in women.

**Methods:** 68 women (70±12 y) with (+) or without (-) LAD stenosis ≥70% who underwent rest TL-201/stress Tc-99m sestamibi with (+) and without (-) AC were retrospectively identified. AC was performed with a commercially available gadolinium source to generate a transmission scan simultaneously with the supine emission scan. All women had: breast shadow on the raw data; LAD segmental defects as per AHA/ASNC position statement; no prior anterior infarction; diagnostic angiography within 30 days. Perfusion was scored based on 5-point/17-segments model, and percent myocardium in the LAD segmental perfusion defects (%LV) was calculated from the scores. Diagnostic interpretation was scored as: 1=definitely abnormal; 2=probably abnormal; 3=equivocal; 4=probably normal; 5=definitely normal. Wilcoxon signed rank test (for %LV) and McNemar's test (p<0.05) were used to compare AC (+) and AC (-) scans.

**Results:** See Table.

**Conclusion:** AC yielded larger estimates of the extent of segmental LAD defects, and improved specificity, accuracy, and diagnostic interpretation with preserved sensitivity. This data suggests a rationale for using AC in older women with apparent breast shadows.

	%LV N=68	%LV LAD (-) N=46	%LV LAD (+) N=22	Sensitivity	Specificity	Accuracy	Definitely normal or abnormal
AC (-)	6%	4%	10%	86%	59%	67%	51%
AC (+)	8%	5%	12%	86%	76%	79%	82%
p	0.001	0.03	0.01	NS	<0.0001	0.008	0.0002

4:45 p.m.

**861-6 Impact of Pharmacologic Stress / Rest Myocardial Perfusion Imaging with Positron Emission Tomography and Rubidium-82 on Invasive Procedure Utilization, Cost, and Outcomes in Coronary Disease Management**

Michael Merhige, Joseph Oliverio, Victoria Shelton, George Watson, Kimberly Smith, Shannon Frank, Gary Stern, David Avino, Anthony Perna, State University of New York at Buffalo, Buffalo, NY, The Heart Center of Niagara, Niagara Falls, NY

**Background:** Myocardial perfusion imaging using positron emission tomography, i.v. dipyridamole and Rb-82 (PET-MPI), provides more accurate detection and quantitation of potential myocardial ischemia than does single photon imaging (SPECT), and thus may reduce the demand for subsequent diagnostic coronary arteriography (ANGIO), the necessary prerequisite for PTCT or CABG (REVASC). Accordingly, we hypothesized that routine use of PET-MPI, compared with SPECT, in patients with suspected coronary disease (CAD), should reduce costs in coronary disease management without worsening patient outcomes.

**Methods:** We assessed downstream utilization of ANGIO and REVASC, as well as one year clinical outcomes in 2159 patients studied with PET-MPI in whom pretest likelihood of CAD was matched to two control groups studied with SPECT: an internal control group of 102 patients and the largest most completely reported multicenter trial of SPECT (END). CAD management costs were calculated using these estimates: SPECT -\$1,000, PET -\$1,850, ANGIO -\$4,800, PTCT -\$10,000, CABG -\$40,000. **Results:** Table 1.

**Conclusions:** CAD Management with PET-MPI results in over 50% reduction in ANGIO and CABG, over 25% reduction in cost, and excellent 1 year outcomes.

Table 1.

	SPECT (END)	SPECT	PET	p value (PET vs. either SPECT)
n	5826	102	2159	
Pretest CAD Probability	0.39	0.37	0.39	n.s.
ANGIO Rate	0.34	0.31	0.13	< 0.003
REVASC Rate	0.13	0.11	0.06	< 0.02
CABG Rate	not reported	0.078	0.034	< 0.0008
PTCT Rate	not reported	0.029	0.028	n.s.
Cardiac Mortality Rate (one year)	0.01	0.02	0.008	> 0.15
Acute MI Rate (one year)	0.01	0.029	0.011	> 0.15
CAD Management Cost per Patient	not reported	\$5,936	\$4,280	

ORAL CONTRIBUTIONS

**863 Cardiac Computed Tomography for Risk Assessment**

Tuesday, March 08, 2005, 4:00 p.m.-5:00 p.m.  
Orange County Convention Center, Room 232A

4:00 p.m.

**863-3 Association Of Elevated C-reactive Protein Levels To The Progression Of Aortic Valve Calcification As Quantified By Electron Beam Tomography.**

Karsten Pohle, Dorette Raaz, Michael Schmid, Dieter Ropers, Christoph Garlachs, Werner Günther Daniel, Stephan Achenbach, Department of Internal Medicine II, Neunkirchen, Germany

**Background:** Aortic valve calcification (AVC) is an actively regulated process with pathophysiologic similarities to atherosclerosis. Electron beam tomography (EBT) allows the detection and exact quantification of calcifications in the aortic valve. The aim of this study was to investigate the association between systemic inflammation and the progression of degenerative calcification of the aortic valve.

**Methods:** In 89 patients (mean age: 66±15 years, 64% men, 59 with statin therapy) with aortic valve calcification, the volume score of AVC in electron beam tomography, C-reactive protein (high-sensitive immunoassay) and LDL-cholesterol was determined. EBT was repeated after a mean interval of 13 months (10 to 14 months), and the relative progression of AVC was calculated.

**Results:** The mean volume score of AVC was 1146.2±1699mm<sup>3</sup> at the initial EBT scan and 1347.7±1932mm<sup>3</sup> at follow-up with a mean relative annual progression of 15.9±29%. CRP was 2.88±2mg/dl and LDL 148.2±38mg/dl (on statins: 114.7±26mg/dl, without statins: 153.2±45mg/dl). Progression of AVC was significantly lower in patients with as compared to without statin therapy (8.3±21%, n = 59 vs. 35.5±39%, n = 30, p<0.001). Mean CRP was significantly higher in the upper tertile of AVC progression (±33.1%) vs. the lowest tertile (<7.4%) [3.71 mg/dl vs. 2.23 mg/dl, p=0.02]. In a multivariate regression analysis, CRP and LDL- cholesterol were independent predictors of the progression of AVC in the total patient group (CRP p=0.03, LDL p=0.04) and in patients without statin therapy (CRP p=0.05, LDL p=0.003). In patients with statin therapy, CRP (p=0.01) but not LDL cholesterol (n.s.) predicted AVC progression.

**Conclusions:** Patients with statin therapy have a significantly lower progression of aortic valve calcifications. C-reactive protein shows an association with the progression of AVC that is independent from lipid-lowering therapy.

4:15 p.m.

**863-4 Aortic Calcification Predicts Hard Coronary Events and is Incremental to Framingham Score**

Jesse A. Davila, Thomas R. Behrenbeck, Tanya L. Hoskin, Terri J. Vrtiska, C. Daniel Johnson, Mayo Clinic, Rochester, MN

Coronary artery calcification is a diagnostic tool in risk stratification of patients complementing algorithms like the Framingham Score (FS), commonly used in preventive cardiology. We studied the potential role of aortic vascular calcification (AVC) in risk stratification and predicting hard cardiac events. AVC in 467 patients (mean age 64 years, range 34 - 83; 275 males) was prospectively studied using low dose abdominal and pelvic CT. AVC scores were obtained from the celiac axis to the aortic bifurcation using commercially available software (GE SmartScore™). AVC was present in 87% of patients, (mean score 977, range 0 - 22,754, 75<sup>th</sup> percentile 3558). Risk factors were measured and entered into the Framingham calculator. Patients were grouped into low, moderate, high risk according to guidelines. Hard events (n = 9) were defined as death from cardiac cause or myocardial infarction. Mean follow-up was 3.1 years (range 0 - 6 years). Kaplan-Meier estimates were calculated for FS and AVC, dividing the study cohort into a lower (≤ 75<sup>th</sup> percentile) and higher risk group (> 75<sup>th</sup> percentile). Spearman rank correlation showed a significant correlation between FS and AVC. Cox proportional hazard models were also calculated with FS as covariate. For all groups, AVC added additional risk information beyond the FS.

Variable	5 year prob. of cardiac event	95% confidence interval
Framingham Risk		
Low	0	-
Moderate	1.4%	0-7.6%
High	5.7%	0.7-14.8%
Calcium Score		
≤ 75 <sup>th</sup> percentile	0.9%	0-3.6%
> 75 <sup>th</sup> percentile	7.2%	1.9-18.9%

P - value = 0.004 for Kaplan-Meier estimates

**Conclusion:** 1) Aortic calcification is predicts risk for cardiac events. 2) It correlates with the Framingham risk score. 3) AVC adds information for risk stratification beyond the Framingham risk score.

4:30 p.m.

**863-5 Coronary Calcium is Independently Predictive of Hard CHD Outcomes in a Young, Unselected Population: 5 Year Outcomes from the Prospective Army Coronary Calcium Project**

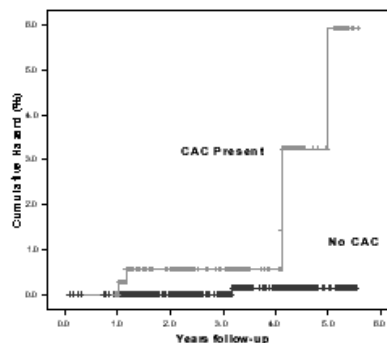
Allen J. Taylor, Jody Bindeman, Tracy Perron, Irwin M. Feuerstein, Michael Brazaitis, Patrick G. O'Malley, Walter Reed Army Medical Center, Washington, DC

**Background:** Controversy remains over the independent predictive value of coronary artery calcium (CAC) detection in unselected populations. We examined the relationship between coronary heart disease (CHD) outcomes and CAC in a long-term, prospective study.

**Methods:** 2000 unselected, asymptomatic, healthy men and women ages 40-50 yrs (mean 43) were evaluated with measured risk variables, including CAC. Incident CHD outcomes were tracked via annual telephonic contacts.

**Results:** The mean 10-year predicted CHD risk (Framingham) was 4.0±2.7%. The prevalence of any detectable CAC was 19.4%. During 5.5 year actuarial follow-up, there were 8 hard CHD events (definite ACS or CHD death), including 7 of 388 individuals with CAC (1.8%) and 1 of 1612 without CAC (0.06%; P <.0001 by log-rank). Cox regression showed that CAC was associated with a 22-fold increased risk for hard CHD (P = .004) after controlling for the Framingham risk score.

**Conclusion:** These data extend the evidence supporting the independent predictive value of CAC for CHD outcomes to a younger, lower risk population. However, because of the low event rate in the overall population, even among those with CAC, avoiding unnecessary testing will require criteria that can optimally select low-risk individuals with the greatest likelihood of benefit from CAC screening.





4:45 p.m.

863-6

**Underestimation of Coronary Risk by Measuring Subclinical Coronary Atherosclerosis in Referral Cohorts: Evidence From the Large Unselected Heinz Nixdorf Recall Cohort**

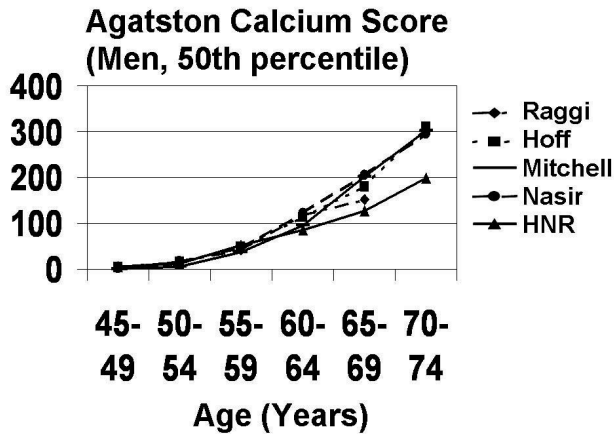
Axel Schmermund, Stefan Mohlenkamp, Sina Berenbein, Heiko Pump, Susanne Moebus, Ulla Roggenbuck, Andreas Stang, Rainer Seibel, Dietrich Gronemeyer, Karl-Heinz Jockel, Raimund Erbel, Heinz Nixdorf Recall Study Investigative Group, University Clinic Essen, Essen, Germany

Coronary artery calcification (CAC) is determined for risk stratification. It is essential to quantify CAC compared with reference data in individuals of the same age and gender. However, the distribution of CAC scores in the unselected general population is not well defined.

**Methods:** The Heinz Nixdorf Recall study (HNR) is a population-based study which recruited a total of 4,814 participants aged 45 - 74 years in the German Ruhr area. CAC scores were determined using electron-beam CT (EBCT) and the Agatston method, and compared with previous reports on referral cohorts (Raggi 2000, Hoff 2001, Mitchell 2001, Nasir 2004).

**Results:** Of the 4,472 (92.9%) subjects with no history of coronary artery disease, CAC scores were available in 4,259 (95%) (2,017 men, 2,242 women). Percentile values were computed in 5-year age-groups for men and women. Analysis of median CAC scores demonstrated significant differences compared with most of the other cohorts. In the higher age-groups (>= 60 years), CAC scores were significantly lower than in 3 of the 4 previous reports (Figure).

**Conclusions:** In a general, unselected population in Europe, CAC scores were lower than in most previous reports which included volunteers and subjects referred by their physicians. Classification of the CAC score with reference to the previous referral cohorts would underestimate true risk when compared with our data in a truly unselected population with no history of coronary artery disease



ORAL CONTRIBUTIONS

**865 Advances in Computed Tomography Coronary Angiography**

Wednesday, March 09, 2005, 8:30 a.m.-10:00 a.m.  
Orange County Convention Center, Hall E2A

8:30 a.m.

865-3

**Noninvasive Coronary Angiography by Retrospectively ECG-gated 64-slice Spiral Computed Tomography: Initial Clinical Experiences**

Dieter Ropers, Katharina Anders, Ulrich Baum, Werner Bautz, Werner Guenther Daniel, Stephan Achenbach, University of Erlangen, Erlangen, Germany

Multidetector computed tomography (MDCT) has been shown to permit coronary artery imaging. However, even with acquisition of 16 slices per rotation, a rotation time of 420 ms and a slice thickness of 0.75 mm, 10 to 15% of the coronary segments are unevaluable. We analyzed the accuracy of a recently introduced 64-slice scanner (Sensation 64, Siemens, Germany) with increased gantry speed for detection of coronary stenoses. 37 patients (27 men, 10 women, mean weight, 84 ± 14 kg, mean age, 59 ± 13 years) referred for invasive coronary angiography due to suspected coronary artery disease were studied by MDCT (64 x 0.6 mm collimation, 375 ms tube rotation, 80 ml contrast agent i.v.). Patients received 100 mg atenolol 60 minutes prior to the scan if heart rate was above 60 bpm. If necessary, up to 20 mg metoprolol were given intravenously immediately before the investigation. Recording of the ECG permitted retrospective reconstruction of contiguous cross sections (slice thickness 0.75 mm in 0.5-mm intervals). In the MDCT images, all coronary artery segments with a diameter of 1.5 mm or more were assessed concerning the presence of occlusions or stenoses exceeding 50% diameter reduction. Results were compared to quantitative coronary angiography.

The mean heart rate was lowered from 71 ± 10 bpm to 58 ± 9 during the scan. Depending on the covered volume (mean 125 ± 14 mm), total breathhold time was between 8.5 and 12.25 s (mean 10.3 s). 138 of 148 coronary arteries (left main, left anterior descending, left circumflex and right coronary artery, including their respective side branches in 37 patients) could be evaluated (93%). In evaluable arteries, 27/29 significant lesions were detected and absence of occlusion or stenosis was correctly identified in 104/109 arteries (sensitivity 93%, specificity 95%). Overall accuracy (including unevaluable segments) was 89% (131/148).

According to this initial data, 64-slice MDCT with isotropic submillimeter resolution, increased gantry speed and consistent premedication with beta blockade permits diagnostic image quality in the majority of patients and allows detection of coronar artery occlusions and significant stenoses with high sensitivity and specificity

8:45 a.m.

865-4

**Noninvasive Quantitative Assessment of Coronary In-stent Lumen by 16-slice Computed Tomography**

Osamu Kuboyama, Tsunekazu Kakuta, Shigeki Kimura, Taishi Yonetsu, Tomoyuki Uemoto, Hideomi Fujiwara, Mitsuki Isoe, Tsuchiura Kyodo General Hospital, Tsuchiura, Japan, Tokyo Medical & Dental university, Tokyo, Japan

**Background:** We investigated the ability of 16-slice multislice CT (MSCT) to assess in-stent lumen by 16-slice MSCT.

**Methods:** We studied a total of 176 stents from 92 consecutive patients referred for conventional angiography (CA) after stent implantation. All patients were studied by both 16-slice MSCT and CA. MIP, MPR, and cross-sectional images of stented segments were assessed with the use of a medium edge enhancement kernel (B41f) and the native reference segments were evaluated with the convolution kernel of B30f. Images were analyzed regarding lumen visibility, quantification of in-stent minimum lumen diameter (MLD) and lesion length by visual assessment in MIP and cross-sectional images of MSCT using digital caliper, and the values were compared with QCA findings. MSCT quantification of MLD and lesion length were evaluated by the use of linear regression analysis and the Bland-Altman analysis with QCA as a reference standard.

**Results:** One hundred fifty-seven stents (89.2%) were evaluable for in-stent lumen. MSCT permitted the detection of 30 of 31 significant (≥50% lumen reduction) stenosis (sensitivity 96.8%), and correctly depicted the absence of restenosis in 107 of 126 stents (specificity 84.9%). These values correspond to positive predictive value of 61.2% (30 of 49), negative predictive value of 99.1% (107 of 108), diagnostic accuracy of 87.3% in evaluable stents and 77.8% in the whole stents. In 30 restenotic stents detected by both MSCT and angiography, mean MLD, reference diameter, and % diameter stenosis by QCA and MSCT were 0.89 ± 0.50mm and 0.82 ± 0.43mm, 2.71 ± 0.60mm and 2.74 ± 0.68mm, 67.0 ± 13.9% and 68.0 ± 15.7%, respectively. Both MLD and lesion length in MSCT correlated closely to QCA findings (r = 0.89, r=0.95, p < 0.001, respectively).

**Conclusion:** MSCT with submillimeter collimation permits reliable visualization of in-stent lumen and correctly detects patients without in-stent restenosis.

9:00 a.m.

865-5

**Multislice CT-Angiography Combined With MRI-Stress Perfusion: Excellent Prediction of Intervention Strategy in Symptomatic Patients With Coronary Artery Disease**

Ralph Haberl, Barbara Richartz, Vanessa Weberndörfer, Eike Böhme, Carola Wagner-Manslau, Jürgen Buck, Andreas Czernik, Peter Steinbigler, Klinik Munich-Pasing, Munich, Germany

**Background:** Multislice CT-angiography (MSCTA) provides impressive images of coronary morphology, however, flow and perfusion information - indicative for coronary intervention - is missing. We therefore tested a combined protocol of MSCTA and adenosine stress MRI perfusion (AS-MRI) for optimal noninvasive prediction of coronary intervention.

**Methods:** We performed MSCTA (Philips 16-slice) and AS-MRI (Philips Intera 1.5T, TF-EPI, 3 short axis slices, adenosine 140µg/kg/min, gadolinium first pass) and invasive angiography (INV-A) in 53 symptomatic patients with angina (16 patients had previous MI and/or stent implantation, acute coronary syndromes excluded). MSCTA was defined abnormal in case of >50% stenosis, AS-MRI was considered abnormal in case of transmural or subendocardial perfusion defect in ≥1 segment during stress not present at rest.

**Results:** With MSCTA 92% of segments (AHA 15-segment model) had diagnostic image quality, AS-MRI could be evaluated in 51 of 53 patients.

Prediction of coronary intervention

n=53	MSCTA	AS-MRI	MSCTA+ AS-MRI
sensitivity	92%	92%	84%
specificity	61%	90%	94%
ppv	68%	88%	95%
npv	89%	93%	100%

Normal MSCTA excluded stenosis requiring intervention with very high accuracy (92%), thus INV-A and AS-MRI can be saved. If MSCTA identified stenosis, but AS-MRI excluded perfusion defect, intervention was rarely needed (increase of specificity and pos. predictive value). In case of abnormal MSCTA and AS-MRI, coronary intervention had to be performed in 21/22 cases.

**Conclusion:** The stepwise approach using MSCTA and AS-MRI allows a strong focus of INV-A on intervention and also to save >30% of diagnostic catheters.

9:15 a.m.

865-6

**Utility of Prototype 256-slice Cone Beam Computed Tomography; Dynamics of Cardiovascular Circulation and Segmented Myocardial Perfusion by Selective Intracoronary Contrast Injection in Four-Dimensional Images**

Nobusada Funabashi, Katsuya Yoshida, Hiroyuki Tadokoro, Keiichi Nakagawa, Kenichi Odaka, Nobuyuki Komiyama, Takanori Tsunoo, Shinichiro Mori, Masahiro Endo, Shuji Tanada, Issei Komuro, Chiba University Graduate School of Medicine, Chiba, Japan, National Institute of Radiological Sciences, Chiba, Japan

**Background:** We employed 256-slice cone beam computed tomography (CT) (Athena, Sony Toshiba) at one rotation per second and a section thickness of 0.5 mm to show dynamics of cardiovascular circulation by intravenous contrast injection and segmented myocardial perfusion by selective intracoronary contrast injection in 4D films.

**Methods:** Six domestic pigs (20 kg each) were anesthetized with isoflurane. Distal tips of catheters were positioned in the left anterior descending branch (LAD) of the coronary artery (pigs 1, 2), left circumflex branch (LCx) (pig 3) or inferior vena cava (IVC) (pigs 4-6). Volumetric scanning and contrast injection were started simultaneously and continued for 25 seconds, and images were reconstructed at half -second intervals.

**Results:** Axial source images 5 seconds after injection revealed segmented left ventricular (LV) myocardial enhancement of the anterior wall and apical portion of inter-ventricular septum (IVS) in pig 1 and 2, and the lateral and posterior walls in pig 3. 4D filming revealed coronary arterial trees, followed by selective 3D images of the anterior, apical and IVS portion of the LV myocardium supplied by the LAD in pigs 1 and 2, and the lateral and posterior portion of LV by the LCx in pig 3. In pigs 4-6, 4D filming revealed dynamics of cardiovascular circulation three-dimensionally, first in the IVC then the right ventricle and pulmonary artery, then the LV, left atrium, and pulmonary vein and finally, the right heart disappeared and only the left heart and aorta remained visible.

**Conclusions:** Using 256-slice CT with intracoronary injection, selective myocardial perfusion images were visualized in 4D. Images of the segmented LV myocardium supplied by each coronary artery are potentially useful to confirm recovery of myocardial micro-vascular perfusion after percutaneous coronary intervention. Also, we demonstrated the cardiovascular circulation in 4D, which could have application in the visualization of cardiovascular circulatory problems. Furthermore, analyzing those data by a time density profile three-dimensionally, quantitative evaluation of blood flow was measured.

9:30 a.m.

865-7

**Identification Of Lipid And Fibrous Coronary Plaque Is Hampered By The Influence Of Contrast Density During Ct Coronary Angiography**

Nico R. Mollet, Filippo Cademartiri, Timo Baks, Nico Bruining, Ronald Hamers, Giuseppe Runza, Pamela Somers, Michiel Knaapen, Stefan Verheye, Pim J. de Feyter, Erasmus Medical Center, Rotterdam, The Netherlands

**Background:** CT coronary plaque characterization is based on absolute plaque density values. However, the effect of intracoronary contrast on the density values of coronary plaques is not yet defined.

**Methods:** Multislice Computed Tomography coronary angiography (MSCT-CA) was performed in 7 ex-vivo left coronary artery specimens (emerged in oil to simulate epicardial fat) filled with 5 solutions with increasing concentrations of contrast material: 1/0, 1/200, 1/80, 1/50 and 1/20. MSCT-CA was also performed in 12 patients (males 9; mean age 58.7 ± 9.9) to evaluate in-vivo the effect of differences in contrast attenuation on plaque density values. These patients underwent two subsequent scans (arterial and delayed) after intravenous administration of a single bolus of contrast material (100 ml of iomeprol 400mg/ml at 4ml/s). The attenuation (HU) value of atherosclerotic plaques was measured in each solution at: lumen, plaque (non calcified thickening of the vessel wall), calcium and surrounding. The results were compared with one-way ANOVA-test and correlated with Pearson's test.

**Results:** The mean attenuation of the 5 solutions in the lumen (45±38 HU; 85±38 HU; 121±38 HU; 322±104 HU; 669±151 HU) and plaque (11±35 HU; 20±38 HU; 34±43 HU; 61±65 HU; 101±72 HU) was significantly different (p<0.001). The attenuation of lumen and plaque of coronary plaques showed moderate correlation (r=0.54; p<0.001). The mean attenuation value in-vivo arterial / delayed for lumen (325±70HU; 174±46 HU) and non-calcified plaque (138±71HU; 100±52HU) was significantly different (p<0.001). The attenuation of calcium and oil was not effected by differences in lumen contrast both in ex-vivo and in-vivo measurements.

**Conclusion:** Non-calcific coronary plaque attenuation values are significantly modified by differences in lumen contrast densities, which should be taken into account with CT plaque characterization based on absolute density values.

9:45 a.m.

865-8

**Radiation Dose and Image Quality in 16-Slice Computed Tomographic Coronary Angiography: Effect of Acquisition Technique**

Thomas C. Gerber, Brian P. Stratman, Ronald S. Kuzo, Birgit Kantor, Richard L. Morin, Mayo Clinic Jacksonville, Jacksonville, FL, Mayo Clinic, Rochester, MN

**Background:** The balance between radiation dose and image quality may become a limiting factor in the use of multislice CT coronary angiography (MSCT-CA). We hypothesized that variations of tube voltage and tube current affect radiation dose more than image quality.

**Methods:** A phantom used by the American College of Radiology for the accreditation of CT imaging programs (Gammex rmi) was scanned on a 16-slice scanner (Siemens Sensation Cardiac; gantry rotation, 375 msec; collimation, 0.75 mm) at permutations of tube current (80 or 120 kVp) and of product of tube current multiplied by exposure time (mAs) (650, 700, or 750 mAs[eff]), with and without dose-sparing "ECG pulsing" (ECG-P). Images were gated at 10% (systole) and 60% (diastole) of the R-R interval of a simulated ECG tracing (rate, 70 bpm) and reconstructed to a slice thickness of 1 mm and a temporal resolution of approximately 97 msec. "Noise" was the standard deviation of the average CT number in the CT number uniformity module of phantom; contrast-to-noise ratio (CNR) was calculated using "contrast" measured in the low contrast module of phantom. The effective dose (E) was calculated from CT dose index measurements with an ionization chamber.

Reconstructions at 60% of R-to-R interval

kVp	mAs <sub>eff</sub>	E (mSv)		Noise	CNR
		ECG-P off	ECG-P on		
120	750	13	9.4	13.8	0.57
120	650	11.3	8.1	15.6	0.49
120	550	9.5	6.9	17.9	0.40
80	750	4.1	3.0	27.8	0.17
80	650	3.6	2.6	30.7	0.17
80	550	3.0	2.2	31.6	0.20

**Conclusions:** Radiation dose increases more than CNR with changes of tube voltage or mAs. Studies are needed to examine the relationship between image quality and diagnostic accuracy of MSCT-CA to establish the necessary tradeoff between diagnostic accuracy and radiation dose.

ORAL CONTRIBUTIONS

**880 Prognostic Aspects of Dobutamine Echocardiography**

Wednesday, March 09, 2005, 10:30 a.m.-Noon  
Orange County Convention Center, Room 230B

10:30 a.m.

880-3

**Aggressive Risk Factor Modification Does Not Reduce New Ischemia by Sequential Dobutamine Stress Echocardiography in Patients With End Stage Renal Disease**

Dhrubo Rakshit, Rodel Leano, Kirsten Armstrong, Nicole Isbel, Thomas Marwick, University of Queensland, Brisbane, Australia

**Background:** Cardiac events (CE) are a major cause of morbidity and mortality in pts with end stage renal disease (ESRD). We sought whether aggressive risk factor modification (ARFM) in pts with ESRD could i) reduce CE (cardiac death and MI) in pts with an abnormal dobutamine stress echo (DSE) and ii) limit development of new ischemia (NI).

**Methods:** 200 patients with ESRD were randomized to either an ARFM strategy (focus group - targeted treatment of hypertension, dyslipidaemia, homocysteine, hemoglobin and phosphate) or usual care (standard group). An intention to treat analysis was performed on 152 pts (mean age 54 yrs, 87 male, 99 dialysis-dependant) who had a baseline DSE (including 53 who had follow up DSE at 2 yrs). Biochemical parameters, cardiac risk factors and investigations (ECG, 2D echo, and carotid intimal medial thickness (IMT)) were recorded at baseline. A positive difference in the peak wall motion score index (WMSI) or positive delta WMSI between follow up and baseline DSE was classed as NI.

**Results:** Mean follow up between baseline and sequential DSE was 2.1 yrs. Between standard and focus groups there was no difference in CE (7 v 10), development of NI (15 v 18), and in pts with an abnormal baseline DSE (non-diagnostic, scar or ischemia) the CE rate was similar (29% v 25%). Predictors of NI are shown below (table)

Variable	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	p	OR (95% CI)	p
Age (yrs)	1.06 (1.03-1.09)	0.001	1.05 (1.01-1.10)	0.01
Abnormal ECG	3.72 (1.65-8.43)	0.002	3.96 (1.43-10.98)	0.008
Duration Diabetes Mellitus (yrs)	1.04 (1.00-1.08)	0.07		
Ejection Fraction (%)	0.96 (0.92-0.99)	0.02		
Previous Cardiac Event	2.56 (1.16-5.66)	0.02		
Diabetes Mellitus	2.61 (1.15-5.90)	0.02		
IMT (mm/10)	1.61 (1.34-2.28)	0.007		

**Conclusion:** ARFM in pts with ESRD does not reduce CE in those with an abnormal DSE nor does it limit the development of NI. Age and abnormal ECG at baseline are independent predictors of NI at 2 years.

10:45 a.m.

**880-4 Chronotropic Incompetence is a Strong Prognosticator In Diabetics Undergoing Dobutamine Stress Echocardiography**

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**Background:** In patients with known or suspected coronary artery disease undergoing exercise stress testing, chronotropic incompetence (CI) is associated with poor prognosis. CI is also frequently seen in dobutamine stress echocardiogram (DSE) and the significance of this is not well known. We examined the role of CI in diabetic patients undergoing DSE.

**Methods:** We examined 329 diabetic patients referred for DSE. CI was defined as an inability in attaining 85% of the maximum predicted heart rate for the age during DSE. Wall motion analysis was performed using a standard 16-segment model. Ischemia was defined as new reversible wall motion abnormality and/or biphasic response. Five-year follow up was obtained for MI and cardiac death and annual event rate was calculated.

**Results:** CI was noted in 128(39.2%) diabetics. Patients were followed for a mean duration of 2.67± 1 years. Significant univariates are described in the Table. By multivariate logistic regression analysis, age (p=0.001), use of beta-blockers (0.002) and LVEF (p= 0.005) were predictors of hard events while ischemia on DSE showed a trend towards worse outcomes (p=0.057). Annual event rate was 5.1% vs. 1.5% (p=0.005) in diabetics with CI vs. no CI.

**Conclusions:** In diabetics, CI is associated with high incidence of ischemia on DSE that showed a trend towards worse outcomes. CI was also associated with a high incidence of B-blocker use, lower LVEF and lower age. CI in diabetics predicted a high hard event rate.

	<85% MPHR on DSE (CI)	>85% MPHR on DSE (No CI)	P value
Age	60±11	63±10	0.01
Males (%)	62.5	41.8	<0.001
Peak Heart Rate	113±22	145±11	
Hypertension(%)	79	82	NS
High Cholesterol (%)	57	51	NS
Prior MI (%)	57	41	<0.001
Beta Blocker use(%)	43	15	<0.001
LVEF (%)	39 ±18	53± 11	<0.001
Ischemia on DSE (%)	61.7	27.9	<0.001
Hard Events (%)	13.6	4.1	0.003

11:00 a.m.

**880-5 Prognostic Implications of Angina During Dobutamine Stress Echocardiography in the Absence of Inducible Wall Motion Abnormalities**

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**Rationale.** Aim of this study was to assess the incidence, clinical correlates and prognostic significance of angina during dobutamine stress echocardiography (DSE) in patients (pts) without inducible wall motion abnormalities.

**Methods.** We studied 1592 pts (age = 61 ± 13 years, 955 men) who underwent high dose DSE and had no new or worsening wall motion abnormalities during DSE. Follow up events were hard cardiac events (cardiac death or non-fatal myocardial infarction) and myocardial revascularization.

**Results.** Angina was induced in 160 (10%) pts during stress. DSE was normal in 1034 (65%) pts, whereas 558 (35%) pts had fixed wall motion abnormalities. During a mean follow up of 4.2 ± 3.1 years, 115 pts died of cardiac causes and 66 pts had non fatal myocardial infarction. Pts with angina during DSE were more likely to have a prior history of exertional angina (60% vs 18%, p<0.005) and received larger doses of dobutamine (37 ± 6 vs 34 ± 9 µg/kg/min, p<0.01) compared to pts without angina. The annual hard cardiac event rate was 2.9% in pts with dobutamine induced angina and 2.7% in pts without (p = NS). Myocardial revascularization was performed more frequently during follow up in pts with than without dobutamine induced angina (38% vs 11%, p<0.0001). In a Cox regression model, independent predictors of hard cardiac events were age (risk ratio [RR] 1.03, 95% confidence intervals [CI] 1.02-1.04, male sex (RR 1.6, CI 1.1-2.2), smoking (RR 1.5, CI 1.1-2.9) and resting wall motion score index (RR 2.7, CI 1.8-3.8).

**Conclusion.** In pts without ischemia by echocardiographic criteria during dobutamine stress, inducible angina is associated with a high incidence of revascularization during follow up. However, the hard cardiac event rate is not different in pts with compared to pts without dobutamine induced angina.

11:15 a.m.

**880-6 Ratio of Left Ventricular Peak E-wave Velocity to Flow Propagation Velocity Assessed by Color M-mode Doppler Echocardiography During Dobutamine Stress Echocardiography: A Potent Predictor of Mortality After Acute Myocardial Infarction**

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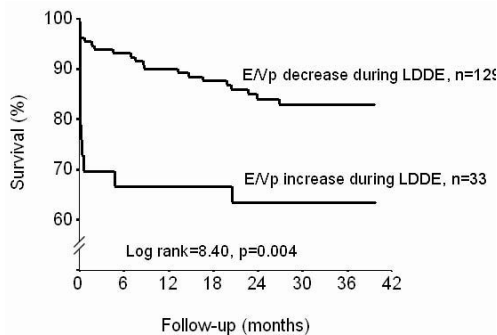
**Background:** The ratio of peak E-wave velocity to flow propagation velocity (E/Vp) assessed by color M-mode Doppler echocardiography is a noninvasive measure of left

ventricular (LV) diastolic filling pressure. We hypothesized that an increase in E/Vp during low-dose dobutamine echocardiography (LDDE), reflecting compromised LV diastolic filling reserve, could provide additional prognostic information beyond conventional stress echocardiographic data after acute myocardial infarction (AMI).

**Methods:** In 162 consecutive patients with a first AMI, LDDE (10 µg/kg/min) was performed 16±6 hours after hospital admission. E/Vp was measured at rest and during dobutamine infusion. Primary endpoint was all-cause mortality.

**Results:** During follow-up of 25±11 months, 33 patients (20%) died. In 33 patients, E/Vp increased during LDDE (mean percent increase from rest to LDDE was 15±14%, p<0.0001), which was associated with increased mortality rate (Figure). On Cox regression analysis, an increase in E/Vp (hazard ratio 2.36 per 0.01 unit increase, 95% CI 1.05-5.30, p = 0.04) was an independent prognostic indicator after adjustment for age, Killip Class, ejection fraction, mitral deceleration time ≤140 ms, E/Vp at rest, and infarct-zone viability by LDDE.

**Conclusions:** An increase in E/Vp during LDDE after AMI, suggestive of a reduced diastolic filling reserve, provides independent prognostic information beyond conventional resting and stress echocardiographic measures of LV systolic function.



11:30 a.m.

**880-7 Levosimendan Echocardiography as a New Test for Detecting Myocardial Viability. A Comparison With Dobutamine Echocardiography**

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**Background:** Levosimendan is a new calcium-sensitizer inotropic agent with positive inotropic and vasodilatory activities but no adrenergic effects, used successfully for treatment of heart failure. Aim of this study was to assess the possible role of levosimendan echocardiography for detection of myocardial viability.

**Methods:** We studied a total of 21 patients (65±10 years, 17 men) with previous myocardial infarction who underwent on two consecutive days dobutamine (increases of 5 µg/Kg/min every 5 min) and levosimendan (24 µg/Kg/min in 10 min) echocardiography before revascularization by either coronary artery by-pass surgery (n=2) or coronary intervention (n=19). Myocardial viability was identified by ≥1 point improvement in regional wall motion in at least two LV regions as assessed on the standard 16-segment model by consensus of two independent readers.

**Results:** Compared with baseline, global wall motion score index (WMSI) was significantly decreased with both levosimendan (1.57±0.41 vs. 1.80±0.42, P=0.0002) and dobutamine (1.61±0.41 vs. 1.80±0.42, P=0.0003). Similarly, global ejection fraction (EF) was significantly increased with both levosimendan (52±10% vs. 44±11% P=0.0001) and dobutamine (49±11% vs. 44±11% P=0.0002). Overall there was a significant agreement between the two tests (kappa=0.62, P<0.0001). Incidence of side effects tended to be lower with levosimendan compared with dobutamine (2 vs. 8 patients, P=0.04). At 6-month follow-up after revascularization, there was a significant improvement of cardiac function (EF= 51±13% and WMSI=1.57±0.38). Viability of each myocardial segment was predicted in a similar way by response to either levosimendan (kappa=0.52) or dobutamine (kappa=0.51). Sensitivity for predicting functional recovery tended to be higher for levosimendan than for dobutamine echocardiography (72% vs. 60%, P=0.18) while specificity tended to be higher for dobutamine (89% vs. 80%, P=0.08).

**Conclusion:** Levosimendan echocardiography is a novel test for identification of myocardial viability after a MI and for prediction of functional improvement after coronary revascularization that compares favorably with dobutamine echocardiography.

11:45 a.m.

**880-8 Relationship Between Systolic and Diastolic Function During Dobutamine Stress Echo in Patients With Coronary Heart Disease**

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**Background:** Cross-sectional studies have demonstrated that left ventricular (LV) systolic and diastolic function are intercorrelated. The extent to which the change in myocardial systolic function correlates with the parameters of LV diastolic function is unclear.

**Methods:** 48 patients with history of coronary heart disease (age 61±10 years, body mass index 26.2±4.1 kg/m²) underwent assessment of wall motion score index (WMSI) and diastolic function at baseline and during low dose dobutamine stress

echocardiography (LDDOB, 10  $\mu\text{g}/\text{kg}/\text{min}$  for 3 minutes, preceded by 5  $\mu\text{g}/\text{kg}/\text{min}$  for 3 minutes). Of the study sample, 88% were men, 79% had previous myocardial infarction (44% anterior, 31% inferior, 4% nonQ). Beta-blocker was taken by 81% of the sample, which was withdrawn 24 hour before the LDDOB. The peak velocities of the early (E) and late (A) LV filling waves and E wave deceleration time (DT) were measured according to standard protocol. The E wave propagation rate (Vp) was assessed by color Doppler M-mode across the mitral valve. The Tei index was calculated as: (isovolumic relaxation time+isovolumic deceleration time)/ejection time. The changes during LDDOB were calculated as:  $100 \times (\text{value during LDDOB} - \text{value at baseline})/\text{baseline}$ .

**Results:** At baseline, WMSI correlated with Tei index ( $r=-0.43$ ) and Vp ( $r=0.65$ , both  $p<0.05$ ), but not with E/A and DT. During LDDOB, WMSI changed by  $-8.3\pm 8.1\%$  (on average, improved) and RR changes by  $-7\pm 12\%$ ; Tei index changed by  $-22\pm 35\%$ , Vp increased by  $38\pm 27\%$ , E/A by  $15\pm 39\%$  and DT by  $8\pm 22$ . During LDDOB, WMSI remained significantly correlated with Tei index ( $r=0.36$ ) and Vp ( $r=-0.60$ ), and not with E/A and DT. However, the change (%) in WMSI from baseline to LDDOB did not correlate with the changes (%) in the parameters of diastolic function (with delta EA  $r=-0.10$ , with delta DT  $r=0.08$ , with delta Vp  $r=-0.22$ , with delta Tei index  $r=0.02$ , all  $p=\text{NS}$ ).

**Conclusions:** While we found that the myocardial systolic function correlated with preload-insensitive parameters of diastolic function (Tei index and Vp) both at baseline and during LDDOB, the change in myocardial contractility function during LDDOB was not a predictor of the changes in the parameters of diastolic function.